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Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

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Executive Summary

This document (Rev. 2) presents a revision to the 2011 (Rev. 1) groundwater monitoring plan[1] for the 216-A-37-1 Crib. This revised monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976*[2] (RCRA), and the implementing requirements in Washington Administrative Code (WAC) 173-303-400,[3] which in turn specifies regulations under Title 40 Code of Federal Regulations 40 CFR 265.[4] This groundwater monitoring plan for indicator parameters is the principal controlling document for conducting groundwater monitoring at the 216-A-37-1 Crib.

Currently, the 216-A-37-1 Crib is a nonoperating interim status treatment, storage and disposal unit, in the 200-EA-1 Soil Operable Unit (OU), which is located above the underlying 200-PO-1 Groundwater OU. The 216-A-37-1 Crib is located southeast of the 200 East Area perimeter fence and was used for percolation to the soil column of evaporator process condensate from the 242-A Evaporator. The 216-A-37-1 Crib began operation in March 1977 and received spent halogenated and nonhalogenated solvents and ammonia. Discharge of the evaporator process condensate to the 216-A-37-1 Crib continued through April 1989 when the crib was removed from service.

In 1994, the bottom of the diversion box was filled with grout to physically preclude the potential for inadvertent discharges to the crib. In July of 2000, vent risers from the crib were sealed to prevent potential passive radioactive emissions. In April 2007, the remaining space in the diversion box was filled with gravel to eliminate any hazard associated with a subsurface void. Subsequently, no additional interim stabilization measures were required.

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[1] DOE/RL-2010-92, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106271470.

[2] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

[3] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-400.

[4] 40 CFR 265, "Interim Status Standards for Owners and operators of hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-part265.xml.

A groundwater quality assessment program in accordance with 40 CFR 265 was implemented in 1997.[5] The groundwater quality assessment plan combined the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs based on the proximity, similarities in construction, waste history, and hydrogeologic regime of the three cribs. In 2010, a separate site specific groundwater monitoring plan was developed for the 216-A-37-1 Crib[6] to monitor under the indicator evaluation program. Since monitoring for indicator parameters was initiated in 2010, statistical analyses of the RCRA parameters used as indicators of groundwater contamination have not shown an exceedance that resulted in the site entering into a groundwater quality assessment program. Thus, dangerous wastes from the 216-A-37-1 Crib subject to WAC 173-303-040[7] are not considered to have contaminated the groundwater beneath the 216-A-37-1 Crib. Therefore, the site remains under the indicator evaluation program described in 40 CFR 265.92.[8]

This revised plan uses the existing groundwater monitoring well network, as identified in the previous groundwater monitoring plan,[9] with the addition of a second upgradient monitoring well. Groundwater flow direction determinations indicate that a south to southeast flow direction exists beneath the 216-A-37-1 Crib. Groundwater in the 216-A-37-1 Crib monitoring wells will be sampled and analyzed semiannually for the parameters used as indicators of groundwater contamination (pH, specific conductance, total organic carbon, and total organic halogen) and annually for parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) in accordance with 40 CFR 265.92(b)(2)&(3) and (d). Water level measurements will be taken each time a sample is collected to satisfy 40 CFR 265.92(e).

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[5] PNNL-11523, 1997, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1662256.

[6] DOE/RL-2010-92, 2010, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106170793.

[7] WAC 173-303-040, "Dangerous Waste Regulations," "Definitions," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-040.

[8] 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol25/xml/CFR-2010-title40-vol25-sec265-92.xml.

9 DOE/RL-2010-92, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106271470.

This revised RCRA groundwater monitoring plan continues with the same detection monitoring requirements for indicator parameters and water quality constituents of the uppermost aquifer beneath the 216-A-37-1 Crib as the previous plan. This plan addresses the following:

- Number, locations, and depths of wells in the 216-A-37-1 Crib groundwater monitoring network
- Sampling and analytical methods of parameters required for groundwater contamination detection monitoring waste constituents
- Methods for evaluating groundwater quality information
- Schedule for groundwater monitoring at the 216-A-37-1 Crib

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Terms

A	Annually
AEA	*Atomic Energy Act of 1954*
bgs	below ground surface
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CSM	conceptual site model
DOE	U.S. Department of Energy
DST	double-shell tank
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
HSU	hydrostratigraphic unit
ICP	Inductively Coupled Plasma analysis
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
OU	operable unit
PUREX	Plutonium Uranium Extraction
Q	Quarterly
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
S	Semiannually
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
VOC	volatile organic compound
WAC	*Washington Administrative Code*

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1 Introduction

This document presents a revised (Rev. 2) groundwater monitoring plan for the 216-A-37-1 Crib and supersedes the previous plan (DOE/RL-2010-92, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*). This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code* (WAC), and the *Code of Federal Regulations* (CFR) by reference (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards;" 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan monitors indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan also monitors parameters used in establishing groundwater quality.

The 216-A-37-1 Crib is a nonoperating interim status treatment, storage, and disposal (TSD) unit designated as a landfill, as defined in WAC 173-303-040, "Definitions." This TSD unit received small quantities of spent halogenated and non halogenated solvents regulated by 40 CFR 261, "Identification and Listing of Hazardous Waste," as well as ammonia (state only toxicity waste). For regulatory purposes, the TSD unit boundary of the 216-A-37-1 Crib is identified on the current Hanford Facility Dangerous Waste Permit (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit*) Part A Form. An updated RCRA closure plan for the 216-A-37-1 Crib was submitted to Ecology in June 2014 (DOE/RL-2005-88, *216-A-37-1 Crib Closure Plan (D-2-10)*). Closure of the 216-A-37-1 Crib will be coordinated with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as part of the 200-EA-1 Soil Operable Unit (OU). Groundwater cleanup will be addressed under the 200-PO-1 Groundwater OU.

The 216-A-37-1 Crib is located in the 200-EA-1 Soil OU, southeast of the 200 East Area perimeter fence (Figure 1-1). The crib is located above the underlying 200-PO-1 Groundwater OU. The crib was installed for percolation of 242-A Evaporator process condensate to the soil column. Operating records indicate that the 216-A-37-1 Crib began receiving process condensate from the 242-A Evaporator in March 1977. Discharge of the evaporator process condensate to the crib continued through April 1989, when the crib was removed from service.

The purpose of this RCRA plan is to present a groundwater monitoring program for parameters used as indicators of groundwater contamination from the 216-A-37-1 Crib, commonly referred to as an indicator evaluation program. This plan is intended specifically to satisfy monitoring requirements for interim status TSD units, as required by WAC 173-303-400(3) and 40 CFR 265.92. This monitoring plan is the principal controlling document for conducting groundwater monitoring at the 216-A-37-1 Crib.

The previous 216-A-37-1 monitoring network consisted of one upgradient and three downgradient wells. One upgradient well is no longer considered suitable by itself for monitoring upgradient constituent concentrations. This revised plan includes incorporation of an additional upgradient well into the monitoring network. The indicator evaluation program detailed in this revised plan requires semiannual sampling for parameters used as indicators of groundwater contamination, as well as annual sampling for parameters establishing groundwater quality for the two upgradient and three downgradient wells. Water level measurements are required each time a sample is collected to satisfy 40 CFR 265.92(e).

This groundwater monitoring plan addresses the operational history, current hydrogeology, and conceptual site model (CSM) for the 216-A-37-1 Crib and incorporates knowledge about the potential for contamination originating from the crib. Chapter 2 of this plan summarizes background information and references other documents that contain more detailed information. Chapter 2 also describes the 216-A-37-1 Crib, regulatory basis for monitoring, types of waste present, and pertinent geology and hydrogeology beneath the 216-A-37-1 Crib and provides a brief history of groundwater monitoring. A CSM is provided to aid in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes the data evaluation and reporting, Chapter 5 provides an updated outline for a groundwater quality assessment plan, and Chapter 6 contains the references cited in this plan. Appendix A provides the quality assurance project plan (QAPjP), Appendix B contains sampling protocols, and Appendix C provides information for the wells within the groundwater monitoring network.

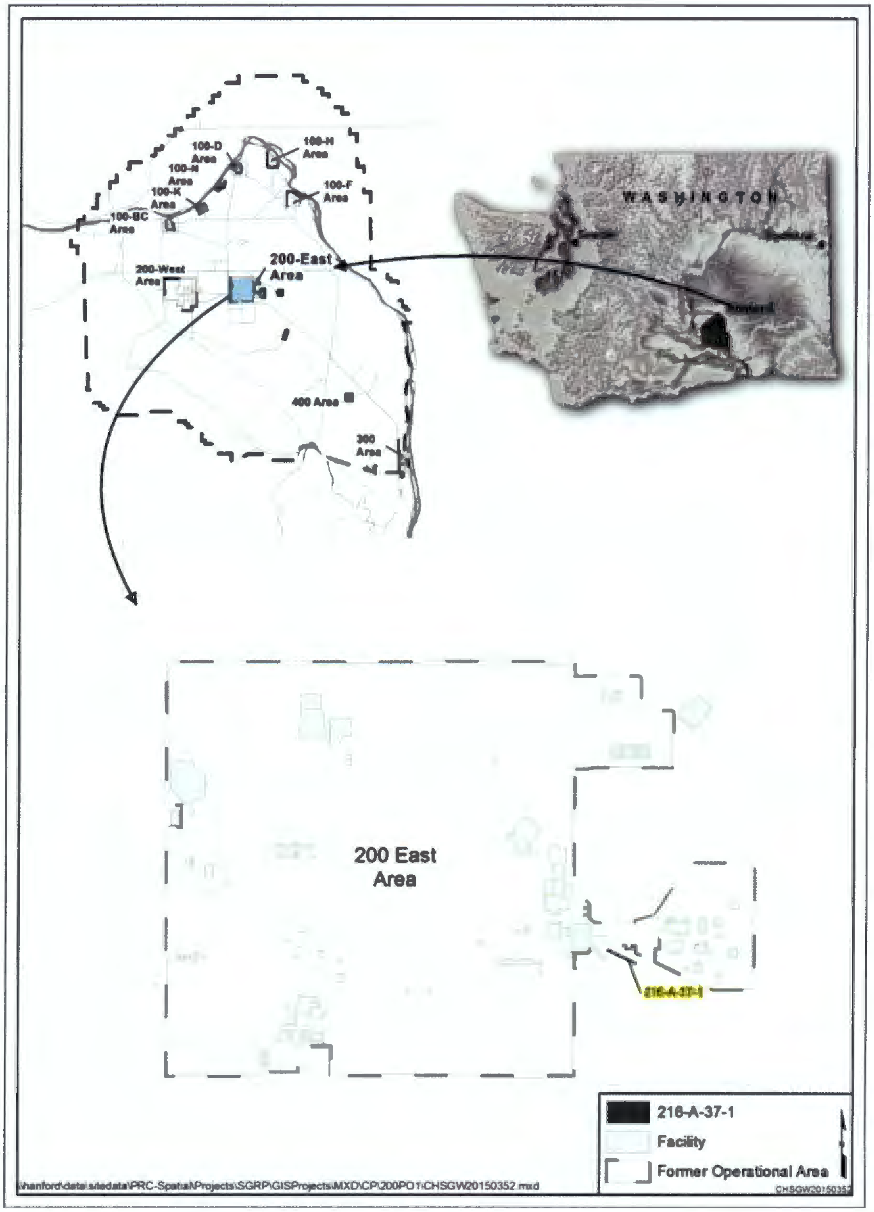


Figure 1-1. Location Map for 216-A-37-1 Crib

2 Background

This chapter describes the 216-A-37-1 Crib and its operating history, regulatory basis, wastes and waste characteristics associated with the 216-A-37-1 Crib, local subsurface geology and hydrogeology, a summary of previous groundwater monitoring, and the CSM for the 216-A-37-1 Crib.

The information contained in this chapter was obtained from several sources, including Waste Information Data System database general summary reports and the following documents:

- DOE/RL-93-88, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*
- DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*
- DOE/RL-2005-88, *216-A-37-1 Crib Closure Plan (D-2-10)*
- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2010-92, Rev. 0, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*
- DOE/RL-2010-92, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*
- DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*
- PNNL-11523, Rev. 0, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*
- PNNL-11523, Rev. 1, *Interim-Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- WHC-EP-0342, Addendum 15, *242-A Evaporator Process Condensate Stream-Specific Report*
- WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*

2.1 Facility Description and Operational History

Constructed in 1976, the 216-A-37-1 Crib is located southeast of the 200 East Area perimeter fence (Figure 2-1). When actively receiving effluent, the crib was about 2.4 to 4.3 m (8 to 14 ft) deep. A 25.4 cm (10 in) diameter perforated, galvanized steel distribution pipe was placed 2m (7 ft) below grade, near the top of the coarse gravel fill and along the centerline of the crib. Waste was pumped to the crib through waste transfer piping to the diversion box located outside of the south end of the crib and, from there, to the crib for disposal. At the crib, the transfer piping connected to the perforated distributor pipe that evenly distributed effluent waste over the length of the crib within an approximate 1.5 m (5 ft) thick bed of gravel. The piping inlet to the crib was at its southeast end, which is at a lower elevation than the northwest end. This configuration favored infiltration at the southeastern end of the crib (Figure 2-2).

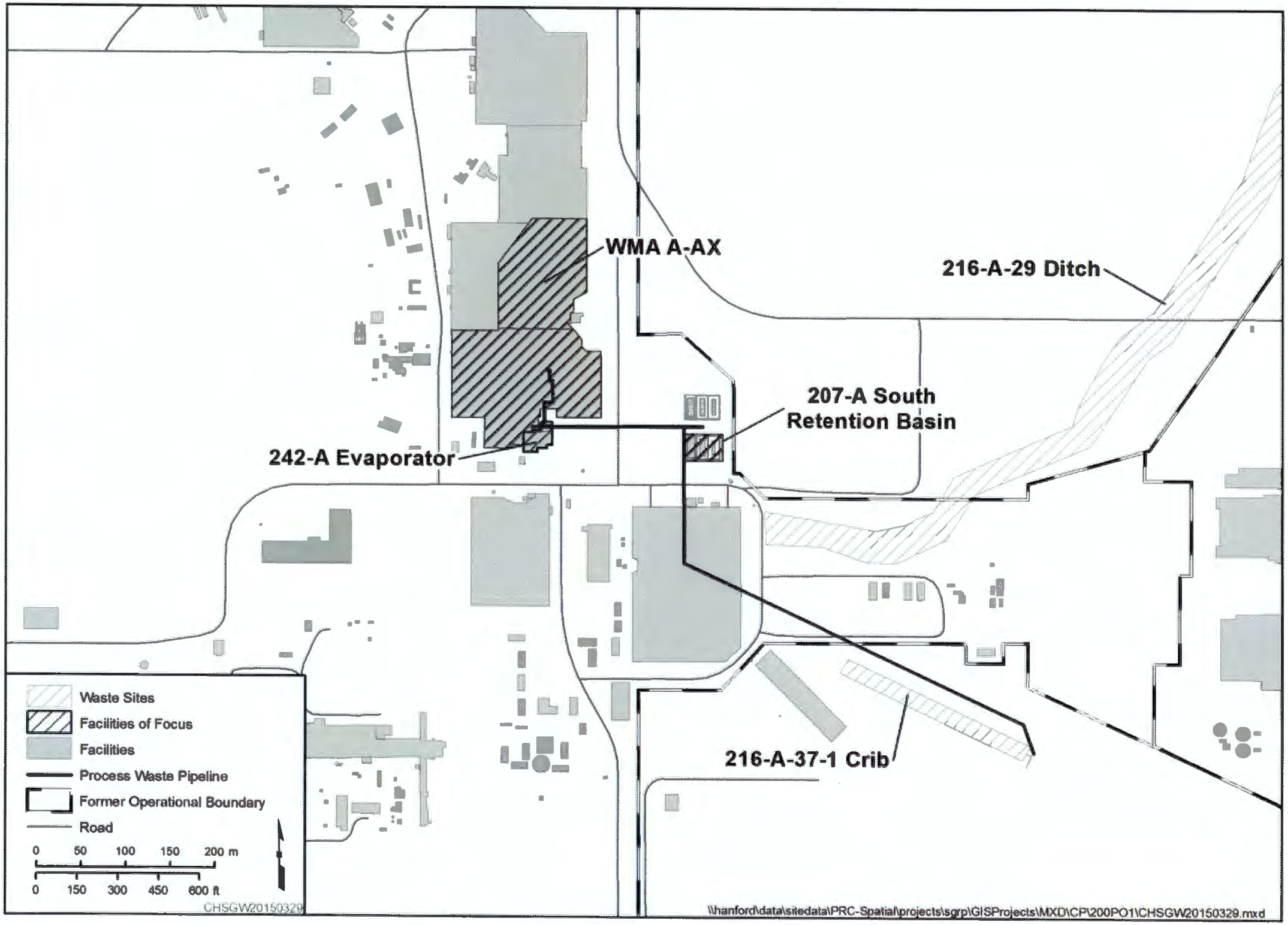


Figure 2-1. Site Map for the 216-A-37-1 Crib and Surrounding Facilities

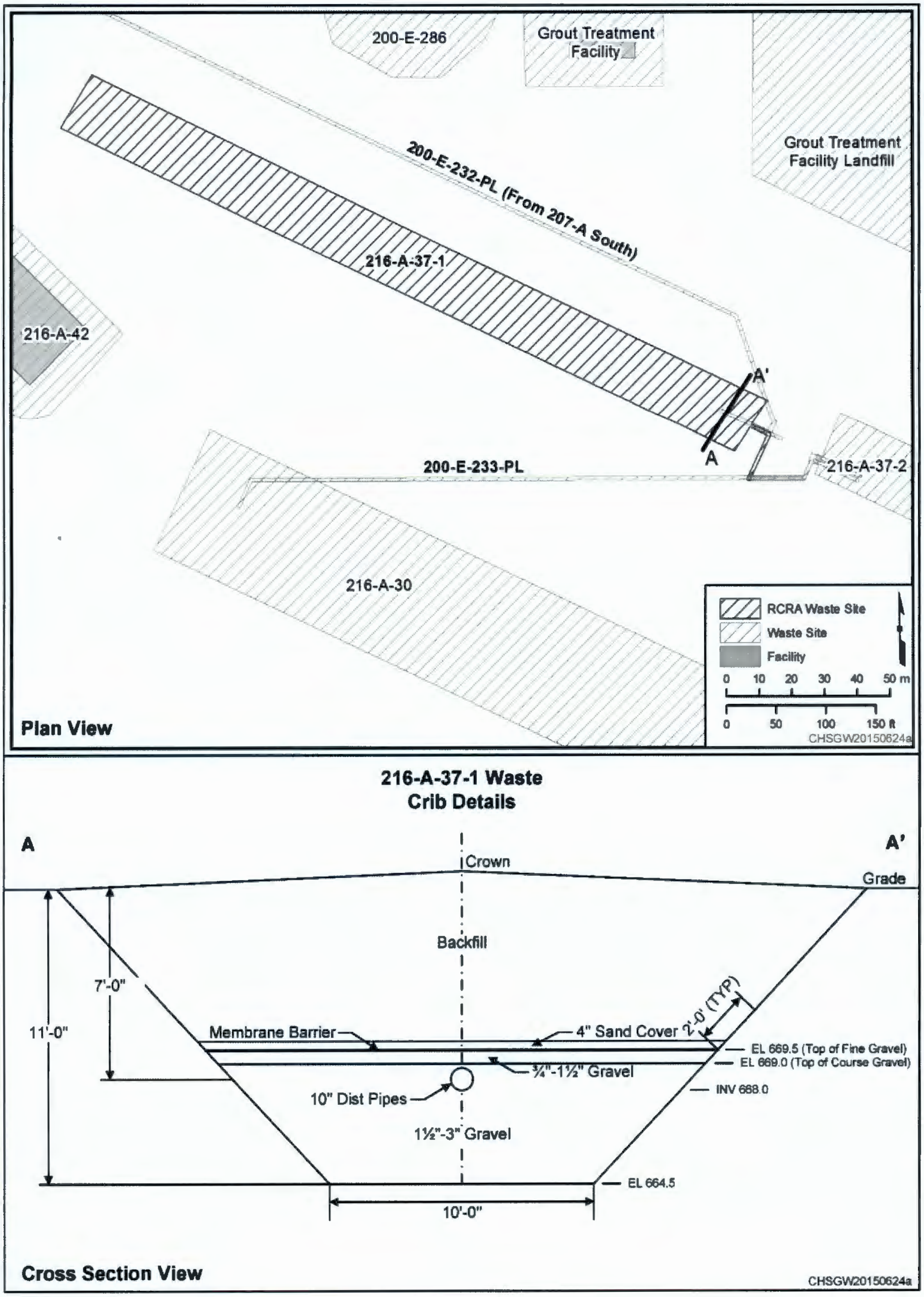


Figure 2-2. Construction Diagram for the 216-A-37-1 Crib

The 216-A-37-1 Crib began operation in March 1977 and was used for percolation of 242-A Evaporator process condensate to the soil column. All waste contributions to the 216-A-37-1 Crib originated from the 242-A Evaporator via the 207-A South Retention Basin. No waste treatment occurred at this TSD unit. The crib received waste water containing spent halogenated and non halogenated solvents and ammonia. Design capacity of the crib was estimated at 327,000 L/day (86,400 gal/day), based on the daily output of the evaporator. Discharge of the evaporator process condensate to the crib continued through April 1989, when the 216-A-37-1 Crib was removed from service. The diversion box was filled with grout to physically preclude the potential for inadvertent discharges to the 216-A-37-1 Crib. During its operational life, the 216-A-37-1 Crib received 3.7×10^8 L (9.8×10^7 gal) of process condensate from the 242-A Evaporator.

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material"), stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized Ecology to regulate these hazardous waste components within the State of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date for regulation of mixed waste in Washington State was August 19, 1987.

In May 1989, DOE, EPA, and Ecology signed the Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site. Groundwater monitoring is conducted at the 216-A-37-1 Crib in accordance with WAC 173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from the waste site have entered the groundwater.

Dangerous waste is regulated under RCRA, as modified in 40 CFR 265 and RCW 70.105, "Hazardous Waste Management," and its implementing requirements in the Washington State dangerous waste regulations (WAC 173-303-400). Radionuclides in mixed waste may include source, special nuclear, and byproduct materials as defined in the *Atomic Energy Act of 1954* (AEA). Both RCRA and AEA state that these radionuclide materials are regulated at DOE facilities, exclusively by the DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the State of Washington under RCRA or RCW 70.105.

The 216-A-37-1 Crib was not monitored under RCRA but was monitored from July 1983 to June 1997 under the *Atomic Energy Act of 1954* (AEA) (DOE/RL-2010-92, Rev. 1). The 216-A-37-1 Crib was one of several liquid effluent discharge sites that were initially excluded from the list of RCRA sites in the Tri-Party Agreement (Ecology et al., 1989). Under Tri-Party Agreement Milestones M-17-00A and M-17-00B, the excluded sites were the subject of a liquid effluent study to determine their environmental impact. As a result, the 216-A-37-1 Crib was monitored along with the non-RCRA active effluent discharge sites by the Operational Monitoring Program (DOE-RL-93-88). Some wells near the crib were also monitored as part of the 216-A-29 Ditch (Figure 2-1) RCRA groundwater assessment monitoring program. Listed wastes were identified in the effluent stream to the 216-A-37-1 Crib, thereby obligating the operator to bring the site into compliance with RCRA regulations.

Discharge to the crib was terminated in April 1989, and a RCRA Permit Application Part A Form was submitted for the site in February 1990. Subsequent investigations indicated the potential presence of chlorinated hydrocarbon solvents from facility operations, and a revised Part A Form was submitted in May 1993. Groundwater monitoring is conducted at the 216-A-37-1 Crib in accordance with

WAC 173-303-400(3), "Interim Status Facility Standards" (and by reference, 40 CFR 265, Subpart F, "Ground-Water Monitoring"), which requires monitoring to determine whether the dangerous waste constituents from the waste site have entered the groundwater.

The RCRA groundwater monitoring program for 216-A-37-1 Crib was initiated in 1997 (PNNL-11523, Rev. 0), based on interim status groundwater quality assessment monitoring requirements of 40 CFR 265(d)(3) and (d)(4) and WAC 173-303-400. In 1997, groundwater monitoring requirements for the 216-A-37-1 Crib, along with the 216-A-10 and 216-A-36B Cribs, were provided in PNNL-11523, Rev. 0. This combined approach was based on the proximity, similarities in construction, waste history, and hydrogeologic regime of the three cribs. The 1997 plan was designed as a groundwater quality assessment program due to elevated measurements of specific conductance in Well 299-E17-9 at the 216-A-36B Crib and the recognition that the three cribs had contributed to radiological and non-radiological groundwater contamination.

The combined groundwater monitoring plan was revised in 2005 (PNNL-11523, Rev. 1) to remove radioactive constituents and far-field wells from the well monitoring network. The 216-A-37-1 Crib was separated from the Plutonium Uranium Extraction (PUREX) Cribs combined groundwater monitoring plan and entered into an indicator parameter evaluation program because specific conductance exceedances under the combined plan were attributed solely to the 216-A-36B Crib groundwater monitoring well (299-E17-9). In 2010, a site specific groundwater monitoring plan (DOE/RL-2010-92, Rev. 0) was developed for the 216-A-37-1 Crib. The separate monitoring plan was developed because the Permit Application Part A Form for the 216-A-10 Crib was removed from the Hanford Facility Dangerous Waste Permit (WA7890008967) in 2010 and, therefore, would not require groundwater monitoring under RCRA. It was also determined that the distance between the 216-A-36B and 216-A-37-1 Cribs was great enough that different monitoring networks were deemed appropriate for these two cribs. The site specific groundwater monitoring plan was updated in 2011 (DOE/RL-2010-92, Rev. 1) to include a section outlining the constituent list and sampling frequency for the first year of monitoring for Well 299-E25-47. First year monitoring was performed to meet upgradient monitoring requirements not previously established. The facility is currently scheduled for closure under RCRA final status, and a closure plan was submitted in June 2014 (DOE/RL-2005-88).

2.3 Waste Characteristics

Discharges received from the 242-A Evaporator process condensate (Figure 2-1) consisted of waste water potentially contaminated with spent halogenated and non halogenated solvents (waste codes F001 through F005) and ammonia (state only toxicity waste codes WT02), as described in the Dangerous Waste Permit Application Part A Form (WA7890009867) for the 216-A-37-1 Crib. Listed waste constituents of concern related to waste numbers F001, F002, F003, F004, and F005 are described in WHC-MR-0517. The constituents are listed in Table 2-1.

Table 2-1. Dangerous Waste Constituents Derived from the Dangerous Waste Permit Application Part A Form Waste Codes for the 216-A-37-1 Crib

Listed Constituent	CAS No.	Listed Waste Number*
Acetone	67-64-1	F003 (State Only)
Cresol–m	108-39-4	F004
Cresol–o	95-48-7	F004
Cresol–p	106-44-5	F004
Methylene Chloride	75-09-2	F002

Table 2-1. Dangerous Waste Constituents Derived from the Dangerous Waste Permit Application Part A Form Waste Codes for the 216-A-37-1 Crib

Listed Constituent	CAS No.	Listed Waste Number*
Methyl Ethyl Ketone	78-93-3	F005
Methyl Isobutyl Ketone	108-10-1	F003 (State Only)
1,1,1-Trichloroethane	71-55-6	F001

Source: WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units.*
Note: Does not include state only toxicity waste codes (WT02/ammonia).
* Dangerous waste source codes are from WAC 173-303-9904, "Dangerous Sources List."
CAS = Chemical Abstract Service

All waste contributions to the 216-A-37-1 Crib originated from the 242-A Evaporator via the 207-A South Retention Basin. Waste processed by the 242-A Evaporator is a mixed waste, as defined in WAC 173-303-040, that was received from the double-shell tank (DST) system. DST mixed waste is an aqueous solution containing dissolved cations and anions, sodium, potassium, aluminum, hydroxides, nitrates, nitrites and a radioactive component. Slurry and process condensate are the two mixed waste streams generated at the 242-A Evaporator. The slurry is returned to the DST system. The process condensate is condensed vapor from the evaporation process. During crib operations, this condensate was transferred to the 207-A South Retention Basin for interim storage before it was disposed at the 216-A-37-1 Crib. The total quantity of waste that was discharged to the crib was limited to the quantity of process condensate effluent waste generated at the 242-A Evaporator that was discharged to the 207-A South Retention Basins and, subsequently, to the crib. The process design capacity of 327,000 L (86,400 gal) per day was based on the potential daily output of the 242-A Evaporator process condensate discharged to the crib via the 207-A South Retention Basin. Approximately 377,011,000 L (99,590,000 gal) of 242-A Evaporator process condensate containing trace quantities of chemicals and radionuclides are estimated to have been discharged to this crib (DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan –Environmental Restoration Program*). The process condensate was mostly water containing small quantities of ammonia and inorganic constituents and trace quantities of volatile organics and radionuclides (WHC-EP-0342). Offgas from the process was routed through a de-entrainment unit, a pre-filter, and high-efficiency particulate air filters before being discharged to the environment. Those constituents with vapor pressures substantially lower than water were likely not removed during the evaporation process and were returned as part of the concentrated slurry to the process system. Those constituents with vapor pressures close to or higher than that of water were likely removed during the evaporation process and directed to the condensate filters and retention basin. The vapor pressure of water is 23.76 mm of mercury at 25°C (77°F). Vapor pressures of cresol-m, -o, and -p are less than 1 mm of mercury at 25°C (77° F) (substantially lower vapor pressure than water). Therefore, these constituents were generally returned to the process system as part of the concentrated solution remaining after evaporation. The other constituents listed in Table 2-1 have vapor pressure near to or higher than water and were likely removed as an offgas during evaporation and treated by a de-entrainment unit and filters prior to being routed to the crib.

Although the 242-A Evaporator was designed to remove dangerous waste constituents from the waste streams, the system was likely not 100 percent efficient. Small quantities of dangerous waste components likely made it to the 216-A-37-1 Crib. Nitrate was the major contaminant detected in groundwater and soil borings.

2.4 Geology and Hydrogeology

The geology and hydrogeology of the 200 East Area, including the region of 216-A-37-1, are described in detail in the following documents:

- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010* (Chapter 2, "Overview of Hanford Hydrogelogy and Geochemistry")
- DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*
- ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site Washington*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*
- CP-57037 (Rev. 0), *Model Package Report Plateau to River Groundwater Transport Model* (Version 7.1)

2.4.1 Stratigraphy

The general stratigraphy at the Hanford Site is presented in Figure 2-3. Stratigraphic units, underlying the 200 East Area within the vicinity of the 216-A-37-1 Crib, include the following (listed in order from upper to lower) (DOE/RL-2009-85):

- A discontinuous veneer of Holocene eolian silty sand or backfill mixtures of sand and gravel.
- Hanford formation – Cataclysmic flood deposits equivalent to hydrostratigraphic unit (HSU) 1. The Hanford formation consists of three facies subunits (silt-dominated, sand-dominated, and gravel-dominated) that grade into one another both vertically and laterally (Figure 2-3). On the central plateau, the Hanford formation is sometimes further delineated into H1, H2, and H3 lithostratigraphic sequences. The H1 and H3 gravel sequences are not differentiated in those areas where the intervening sandy H2 sequence is absent. Units H1 and H3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses. The H2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. Both the sand-dominated H2 and gravel-dominated H3 sequences are present near the 216-A-37-1 Crib.
- Cold Creek unit (CCU) – equivalent to HSUs 2 and 3. The CCU is often undifferentiated but has been subdivided regionally into three subunits which include the Cold Creek unit Z (Early Palouse Soil) and unit C (caliche), both of which are primarily located in 200 West Area, and unit G (pre-Missoula gravels), which is primarily located beneath 200 East Area and vicinity. In much of the 200 East Area, the CCU is characterized as a quartzo-feldspathic sandy gravel (unit G) above the Ringold Formation and below the more basaltic Hanford formation. The Cold Creek unit Z is associated with fluvial overbank to eolian deposits, which can have variable thickness (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and Into the Unconfined Aquifer Below the B-Complex*).

- Ringold Formation unit E – equivalent to HSU 5. Fluvial deposits with thick layers of silty sandy gravel (conglomerate), intercalated with thinner beds of overbank silts and fine-grained paleosols. In the 200 East Area, HSU 5 is present only in the southern portion because, to the north, it has been removed by erosion or non-deposition.

- Ringold Formation, lower mud unit – equivalent to HSU 8. This unit is composed of a sequence of fluvial overbank, paleosol, and lacustrine silt and clay, with minor sand and gravel. This unit is an aquitard, creating confining conditions, and isolating the Ringold Formation unit E from the underlying Ringold Formation unit A when all units are present.

- Ringold Formation unit A – equivalent to HSU 9. Unit 9 can be further subdivided into three hydrostratigraphic units based on markedly different lithologies and hydraulic properties. The primary subunit is characterized as a silt to clay-rich confining zone with lower permeability, classified as unit 9B. Subunits 9A and 9C have much higher permeabliities and lower clay content and consist of consolidated silty sandy gravel deposits.

- Bedrock consisting of Columbia River Basalt flows dip gently to the south toward the axis of the Cold Creek syncline. The two uppermost flows are within the Elephant Mountain Member of the Saddle Mountains Basalt.

Geologic cross sections which include selected wells in the southern portion of the 200 East Area present the approximate stratigraphy underlying and adjacent to the 216-A-37-1 Crib (Figures 2-4, 2-5, and 2-6).

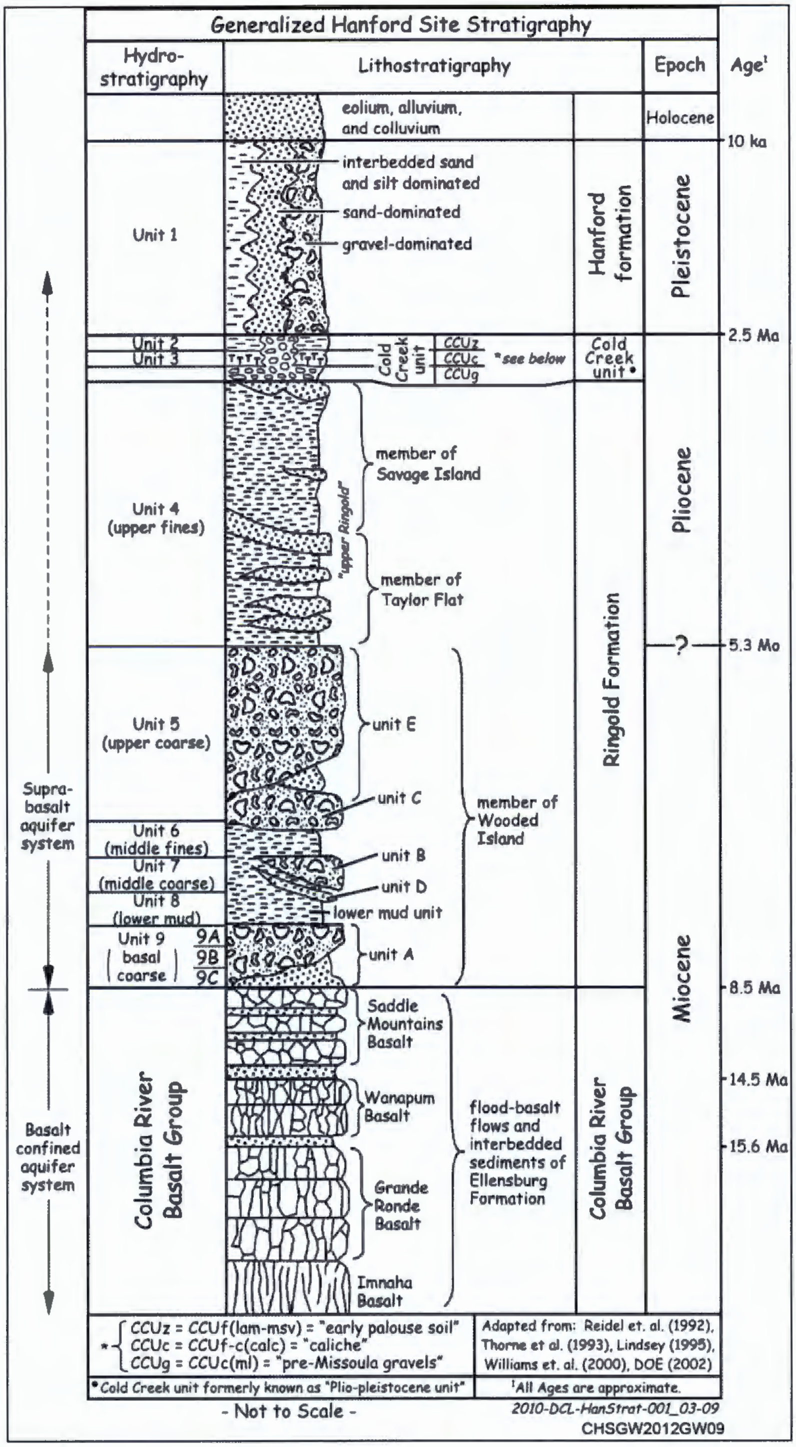
2.4.2 Hydrogeology

The 216-A-37-1 Crib overlies a sequence of Hanford formation and CCU sediments that locally incised and removed the Ringold Formation unit E (HSU 5) and the Ringold Formation lower mud unit (unit 8) (Figures 2-3 through 2-6). As a result, the overlying CCU lies unconformably on the Ringold Formation unit A (HSU 9) or the Ringold Formation lower mud (HSU 8) near the crib. Sediments comprising the Hanford formation and CCU have a relatively high hydraulic conductivity compared to the underlying Ringold Formation. Based on recent groundwater flow and transport modelling iterations, average hydraulic conductivity for the Hanford formation and CCU, where channelized flow occurs, is estimated to be approximately 17,000 m/day (55,777 ft/day) and 2.27 to 109 m/day (7.45 to 357.6 ft/day) in those areas without channelized flow where older sediment occurs (CP-57037). Due to high hydraulic conductivity, the water table in the area where the crib is located is very flat with an extremely low gradient. The current water table elevation is 121.80 m (399.6 ft) above mean sea level and occurs within the Hanford formation or CCU in the vicinity of the 216-A-37-1 Crib (Figures 2-4, 2-5, and 2-6).

2.4.3 Groundwater Flow Interpretation

Historically, water levels in the unconfined aquifer increased as much as 5.5 m (18 ft) above the pre-Hanford natural water table level near the PUREX Cribs (i.e., 216-A-10, 216-A-36B, and 216-A-37-1). This increase was the result of artificial recharge from liquid waste disposal operations (e.g., PUREX Cribs and B Pond) (Figure 2-7) between the mid-1940s and 1997. The pre-Hanford groundwater flow was to the east and southeast in the southeastern portion of the 200 East Area. While the 216-B-3 Pond (B Pond consisting of 216-B-3-1, 216-B-3, 216-B-3A, 216-B-3B, and 216-B-3C) was in operation, artificial recharge created a significant groundwater mound, resulting in a radial flow pattern around B Pond that impeded flow towards the east and redirecting it to the southwest. As discharges to B Pond ceased, the mound at B Pond subsided, and groundwater flow directions in the southeastern portion of the 200 East Area and vicinity of the 216-A-37-1 Crib began to change. Currently, the unconfined aquifer in the 200 East Area has a very low hydraulic gradient, making it difficult to determine groundwater flow direction. The hydraulic gradient of the water table in the area around the

216-A-37-1 Crib is calculated to be 2.3 × 10^{-5} meters per meter (DOE/RL-2014-32). Estimated flow directions in different portions of the 200 East Area have been determined through statistical analysis of water levels obtained from wells comprising the low gradient monitoring well network in conjunction with tracking contaminant plume movements (Figure 2-7). In 2013, the local groundwater flow direction near the 216-A-37-1 Crib was interpreted to have an azimuth of approximately 166 degrees +/- 20 degrees, based on measurements from the adjacent 216-A-29 low gradient monitoring network (Figure 2-8). Water table elevations and local flow directions occasionally show temporary changes due to discharges from the 200 East Area Treated Effluent Disposal Facility and possibly from elevated Columbia River water level (SGW-54165).



Source: DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*.

Figure 2-3. General Stratigraphy at the Hanford Site

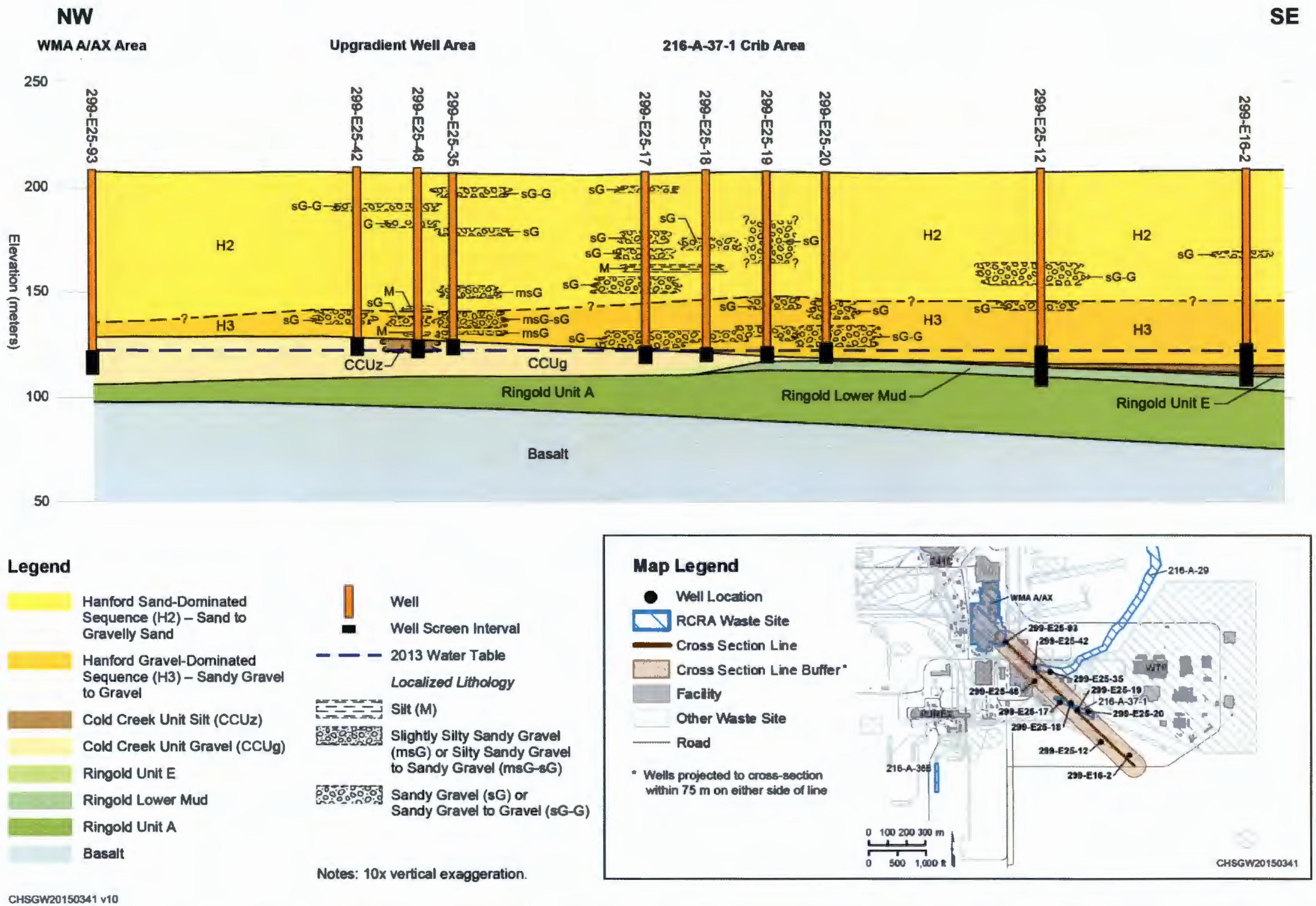


Figure 2-4. Northwest-Southeast Geologic Cross Section Showing the Stratigraphy below the 216-A-37-1 Crib

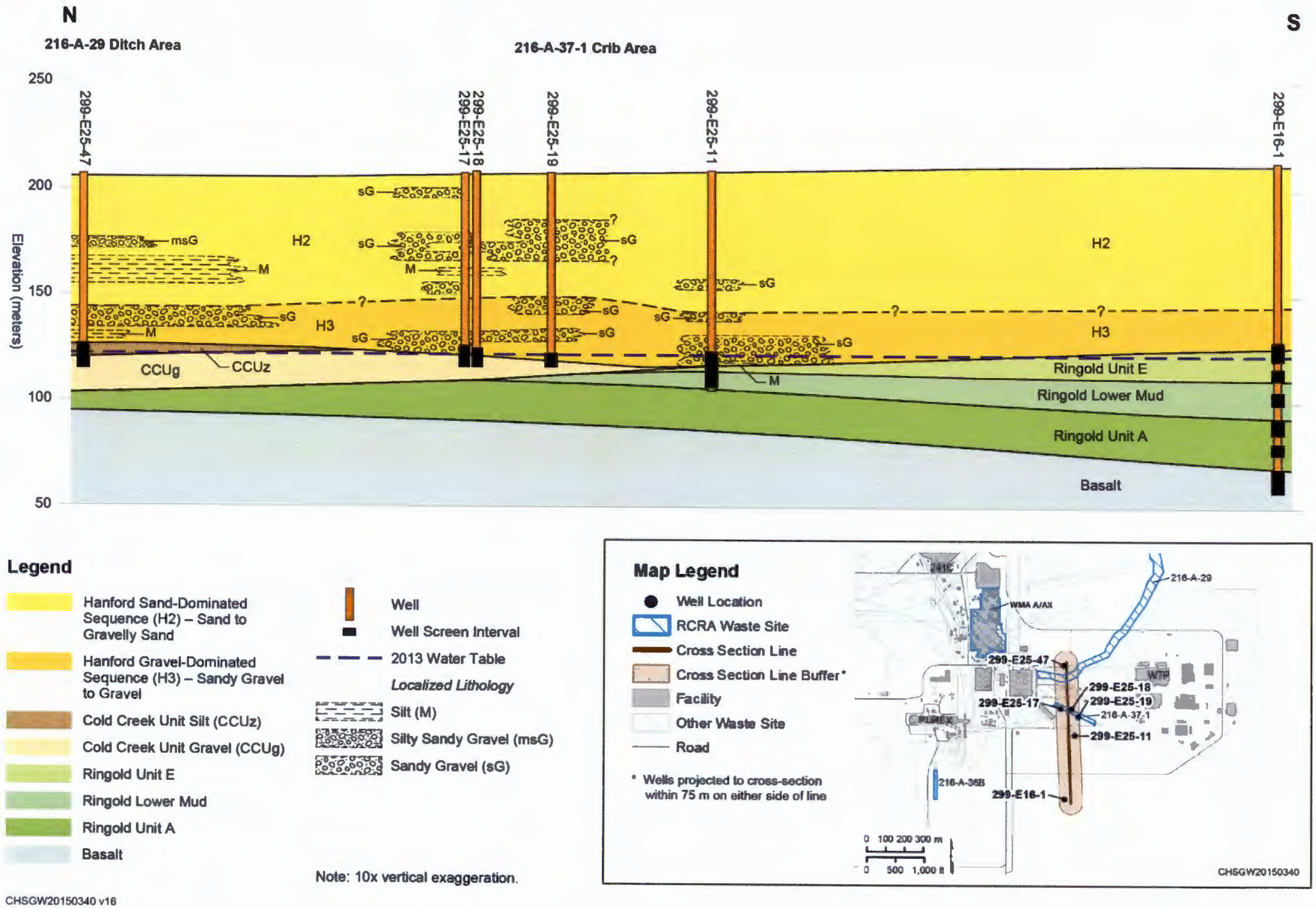


Figure 2-5. North-South Geologic Cross Section Showing the Stratigraphy below the 216-A-37-1 Crib

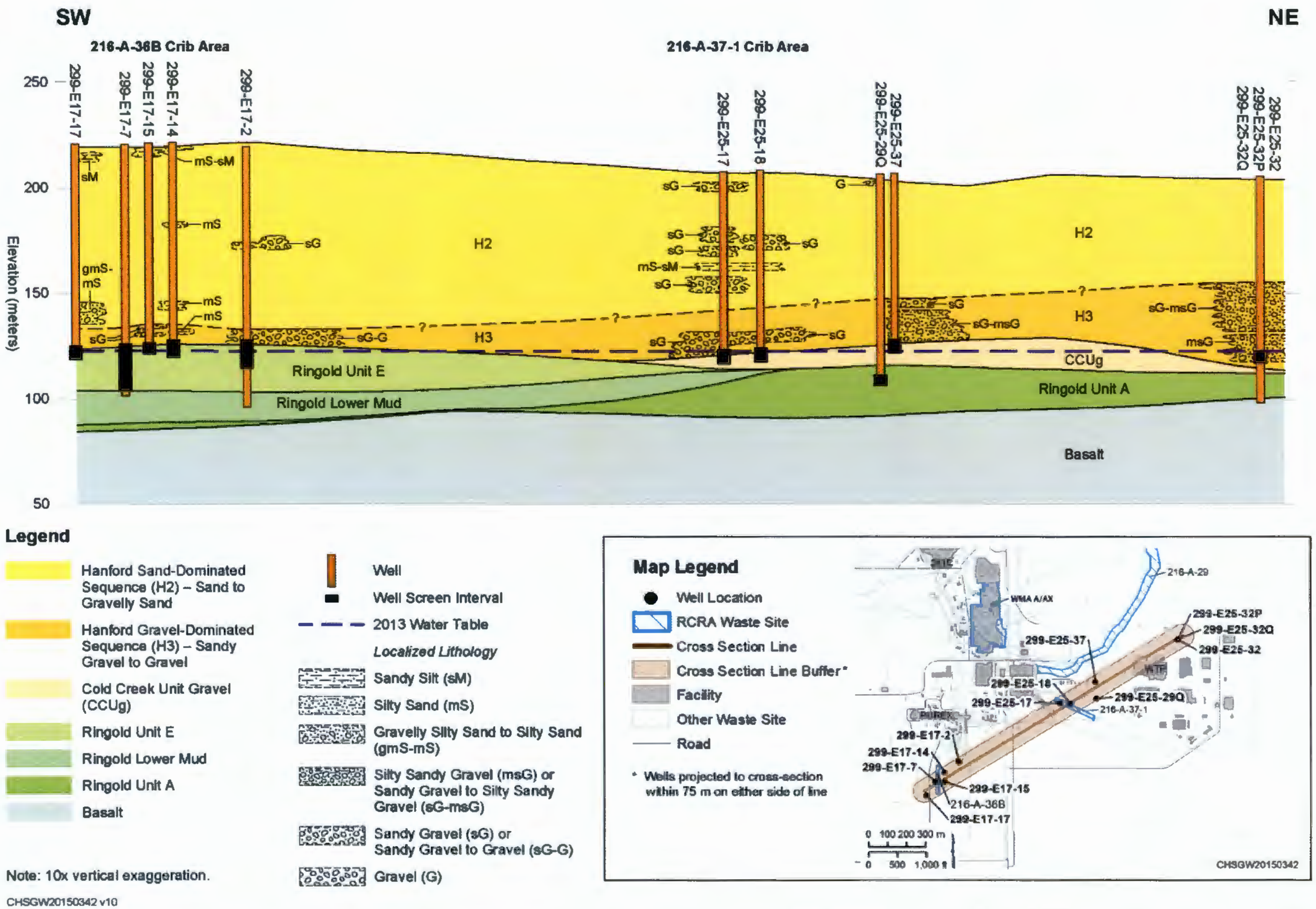
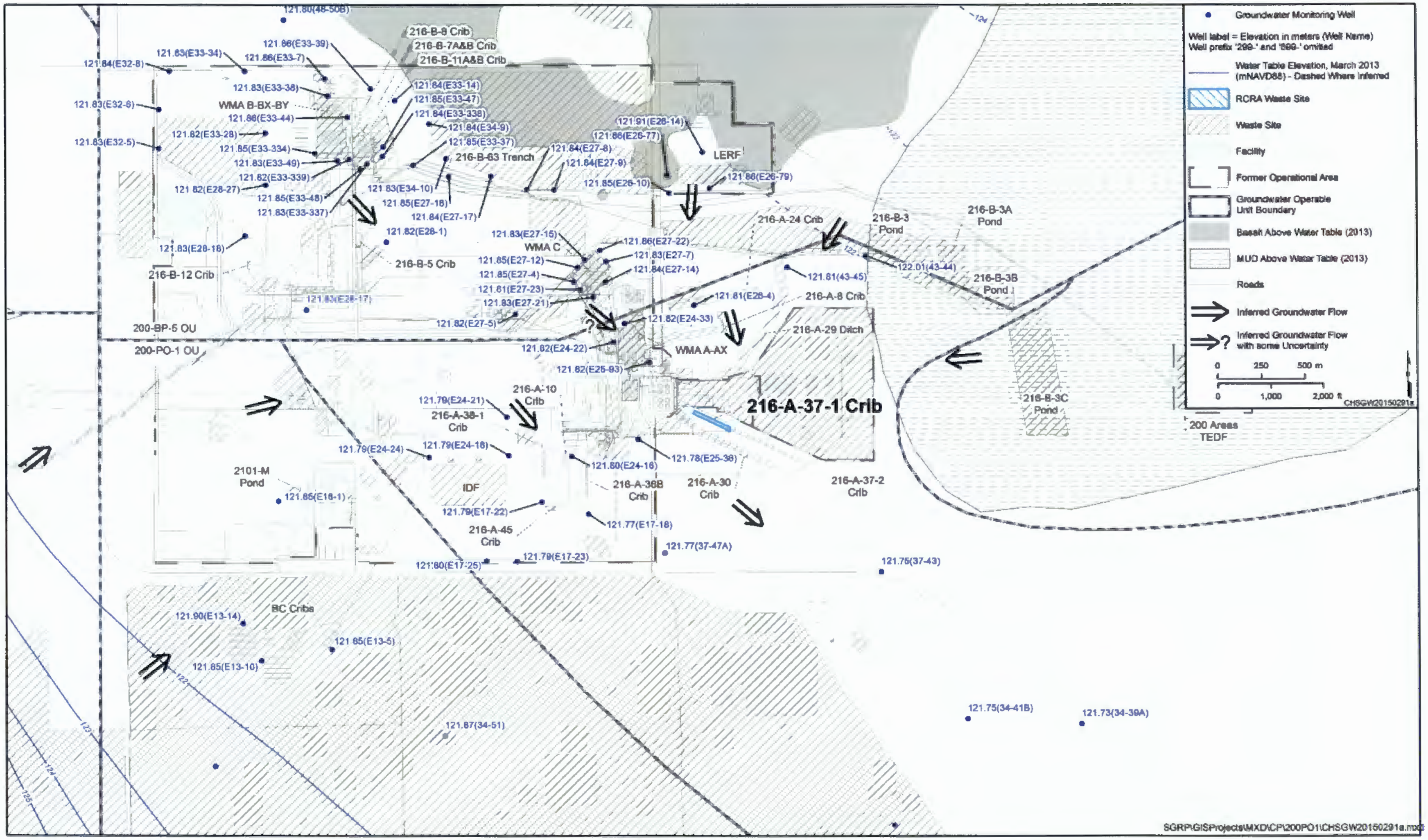


Figure 2-6. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy Underlying the 216-A-37-1 Crib



Source: NAVD88, *North American Vertical Datum of 1988*.

Figure 2-7. Water Table Elevations and Local Groundwater Flow Directions for the 200 East Area

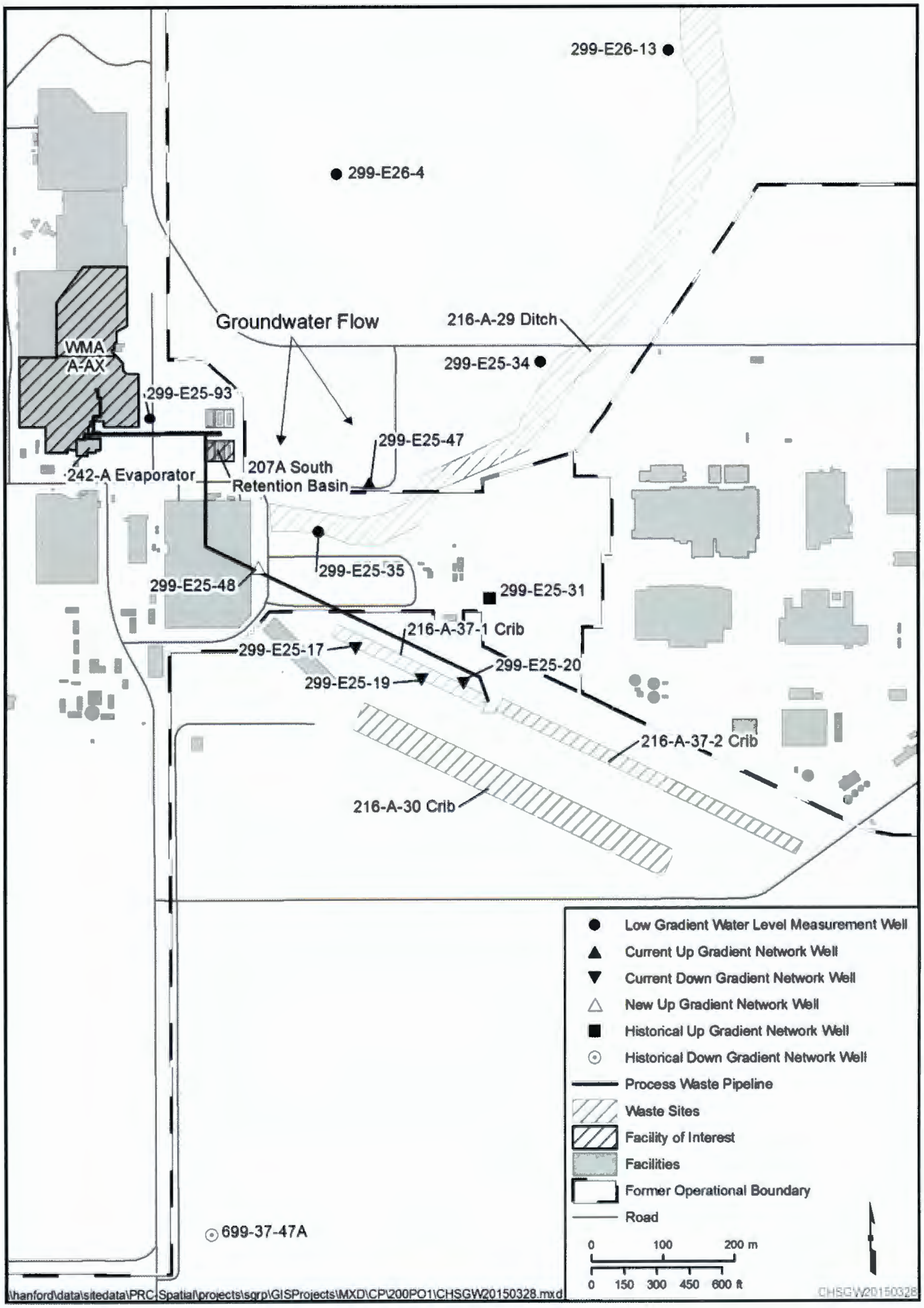


Figure 2-8. Estimated Local Flow Direction and Monitoring Networks near the 216-A-37-1 Crib

2.5 Summary of Previous Groundwater Monitoring

Groundwater monitoring was initiated at the 216-A-37-1 Crib in 1983 under AEA. The waste site was monitored from July 1983 to June 1997 under the Hanford operational groundwater monitoring and the Hanford surveillance monitoring programs. Monitoring specification associated with the site have evolved since 1983 in response to implementation of RCRA monitoring requirements, recognition of changing groundwater flow directions, and evaluation of ground monitoring results.

Elevated concentrations of groundwater contaminants resulting in high specific conductance discovered during Hanford operational groundwater monitoring programs at the PUREX Cribs (Well 299-E17-9 located at the 216-A-36B Crib) provided the basis for requiring RCRA groundwater quality assessment monitoring (WAC 173-303-400 and, by reference, 40 CFR 265.93[d][3] and [d][4]). In 1997, RCRA monitoring of the 216-A-37-1 Crib was initiated in conjunction with the 216-A-36B and 216-A-10 Cribs through utilization of an 11 well near-field monitoring network designated as part of an assessment monitoring program (PNNL-11523, Rev. 0). The 216-A-37-1 Crib monitoring network included one upgradient (299-E25-31) and three downgradient wells (299-E25-17, 299-E25-19, and 699-37-47A) in the vicinity of the waste site (PNNL-11523, Rev. 0) (Figure 2-8). Wells designated as part of the 1997 monitoring network were retained in a revision to the PNNL-11523 (Rev. 0) monitoring plan published in 2005 (PNNL-11523, Rev. 1).

Based on sampling results collected under the 2005 groundwater monitoring plan, the 216-A-37-1 Crib was determined to be responsible for nitrate groundwater contamination and associated elevated specific conductance. Nitrate is not a dangerous waste constituent listed in Appendix 5 of WAC 173-303-080, "Dangerous Waste Lists," and 173-303-100, "Dangerous Waste Criteria" (Ecology Publication No. 97-407, *Chemical Test Methods For Designating Dangerous Waste WAC 173-303-090 & -100*). Therefore, indicator parameter evaluation (WAC 173-303-400(3), incorporating 40 CFR 265.92 through 265.93[b][3]) was determined to be the appropriate program for the 216-A-37-1 Crib. In 2010, PNNL-11523 (Rev. 1) was replaced by DOE/RL-2010-92 (Rev. 0) as a site-specific monitoring plan for the 216-A-37-1 Crib. A replacement for PNNL-11523 was required because one of the three cribs (216-A-10) of the plan had its Permit Application Part A Form removed from the Hanford Facility Dangerous Waste Permit (WA7890008967). At that time, two separate monitoring well networks were considered appropriate for the remaining cribs (216-A-36 and 216-A-37-1). In 2011, DOE/RL-2010-92 (Rev. 0) was revised to include the sampling frequency and constituent list for the first year of monitoring. The well network remained unchanged in DOE/RL-2010-92 (Rev. 1). Table 2-2 provides a summary of groundwater monitoring plans of the 216-A-37-1 Crib.

Table 2-2. Summary of Groundwater Monitoring Plans for the 216-A-37-1 Crib

Document	Date Issued	Monitoring Program*	Summary
PNNL-11523, Rev. 0	June 1997	Groundwater Quality Assessment	Plan developed because the 216-A-37-1 Crib required groundwater monitoring under RCRA. Three RCRA waste sites were combined into one groundwater assessment program.
PNNL-11523, Rev. 1	July 2005	Groundwater Quality Assessment	Updated well monitoring network and site specific constituents. Continued well network coverage of three waste sites under one monitoring plan.

Table 2-2. Summary of Groundwater Monitoring Plans for the 216-A-37-1 Crib

Document	Date Issued	Monitoring Program*	Summary
DOE/RL-2010-92, Rev. 0	October 2010	Indicator Evaluation Program	216-A-37-1 site-specific RCRA groundwater monitoring plan. Indicator evaluation program was initiated for 216-A-37-1 Crib.
DOE/RL-2010-92, Rev. 1	June 2011	Indicator Evaluation Program	This plan updated the previous plan to include the constituent list and sampling frequency for monitoring during the first year.

* The Indicator Evaluation Program satisfies the requirements of 40 CFR 265.92(b)(2), (b)(3), (d)(1), (d)(2), and (e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." The groundwater quality assessment program's first determination satisfies the requirements of 40 CFR 265.93(d)(4) and (d)(6), "Preparation, Evaluation, and Response."

2.5.1 Evolution of the Well Network and Monitoring Results

While the 216-B-3 Pond (B Pond) was in operation, the groundwater flow direction was in a radial pattern from the pond. Cessation of wastewater discharge to B Pond led to changes to the local groundwater flow direction in the vicinity of the 216-A-37-1 Crib, from west to south. From 1997 until 2005, Well 299-E25-31, located northeast of the crib, was utilized to monitor upgradient conditions when flow towards the west was occurring (Figure 2-8). The location of Well 299-E25-31 was appropriate as an upgradient well for the 216-A-37-1 Crib at that time because it was located between the pond and the crib.

AEA monitoring conducted for the PUREX Cribs prior to 1997 detected ammonia (ammonium ion). Ammonium ion (more recently ammonia) was analyzed in groundwater samples through 2006, but analyses for this constituent were discontinued due to infrequent detections. Detected results ranged from the method detection limit (approximately 7 μg/L) to 850 μg/L. Similarly, volatile organic compounds (VOCs) were analyzed in groundwater samples collected from 1987 to 1994 for the PUREX Cribs (i.e., 216-A-10, 216-A-37-1, and 216-A-36B) but were discontinued because VOCs were not detected. Throughout much of that time period, however, the method detection limit was 5 μg/L. Since that period, lower detection limits (e.g., 1.00 μg/L) were utilized for analysis of VOCs.

Since 1996, other constituents have been detected (e.g., zinc, chromium, arsenic, and vanadium). Detections for zinc and chromium occur intermittently; zinc has shown low concentration level trending, and chromium levels have always been below the drinking water standard (DWS). Arsenic concentrations have been at background levels (the 95 percent confidence level is 11.8 μg/L [DOE/RL-96-61]).

In 2005, in response to changing flow directions, Well 299-E25-31 was no longer considered suitable as an upgradient well for the monitoring network and was replaced by Well 299-E25-47 (which is compliant with WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells"). Well 299-E25-47 is north of the 216-A-37-1 Crib and provided better representation of upgradient groundwater (Figure 2-8). This well is located near the 216-A-29 Ditch and has been sampled since 1992 in conjunction with the CERCLA monitoring program. Another well change occurred in 2010 as part of the monitoring network revisions presented in DOE/RL-2010-92 (Rev. 0); Well 699-37-47A was removed as a downgradient well, and existing Well 299-E25-20, which had been sampled since 1980, was added to provide coverage for the southeastern end of the crib (Figure 2-8).

Monitoring conducted between 1995 and 2014, identified a continued presence of nitrate below the 216A-37-1 Crib, occurring at concentrations exceeding the DWS. Currently, a nitrate plume occurs beneath the southeastern portion of the crib (Figure 2-9). Plume delineation underlying the waste site is based on a nitrate concentration above the 10 mg/L DWS nitrogen in nitrate (equivalent to 45 mg/L nitrate). Nitrate concentrations have gradually been increasing, with the highest levels generally being associated with Well 299-E25-20, located at the southeastern end of the crib (Figures 2-8 and 2-10). Concentrations above the DWS have not historically been observed in upgradient wells. The ongoing presence of a nitrate at the 216-A-37-1 Crib indicates that the crib is a probable source of nitrate contamination. West of the 216-A-37-1 Crib, a more extensive nitrate plume trends across the western portion of the 200 East Area in the vicinity of the 216-A-10 and 216-A-36B Cribs (Figure 2-9), extending into the 200-BP-5 Groundwater OU, located to the north of the 200-PO-1 Groundwater OU. Nitrate plumes in the 200 East Area are monitored under CERCLA by the well networks associated with the 200-PO-1 and 200-BP-5 Groundwater OUs (Figure 2-9).

Increasing sulfate concentrations have been noted in the downgradient network wells since 1996. Downgradient Well 299-E25-17 has shown the greatest rate of increase and the highest sulfate concentrations (Figures 2-8 and 2-11). In this well, sulfate has been above the secondary DWS (250 μg/L) since about 2001. The increasing sulfate values observed in the network wells are consistent with recent mapping of sulfate levels in the 200 East Area (Figure 2-12). Encroachment of the sulfate plume is also shown by rising conductivity values observed in upgradient Well 299-E25-48 (Figure 2-14). This well will be utilized in the revised monitoring network presented in this plan (see Chapter 3) to reflect upgradient conditions impacting the 216-A-37-1 Crib appropriately. Some of the higher concentration regions of the sulfate plume are migrating toward the 216-A-37-1 Crib, as seen in the rising specific conductance values measured in Well 299-E25-17 (Figure 2-13). Specific conductance has also been increasing in upgradient Well 299-E25-47, as it has for other wells along the 216-A-29 Ditch and 216-A-37-1 Crib. Increasing concentration trending of nitrate and sulfate correlates with the increasing conductivity values measured in network wells.

During the first year of implementation of DOE/RL-2010-92 (Rev. 0), the primary objective of monitoring was to establish initial background concentrations in accordance with 40 CFR 265.92(c)(1) and (2) for Well 299-E25-47. Well 299-E25-47 (the upgradient well) was sampled quarterly for the indicator parameters (pH, specific conductance, total organic carbon, and total organic halogen) and groundwater quality parameters (chloride, iron, manganese, phenols, sodium, and sulfate), and semiannually for VOCs, because it did not have sufficient data as a RCRA monitoring well and had little background data. In the established downgradient wells, indicator parameters and VOCs were analyzed semiannually, and groundwater quality parameters and alkalinity were analyzed annually. The field parameters (temperature, turbidity, and water level) were collected every time the wells were sampled. Per DOE/RL-2010-92 (Rev. 0), if any VOCs were detected in downgradient wells (and not upgradient wells), analysis for the detected constituents would continue. VOCs were not detected and will no longer be analyzed. Following completion of the first year monitoring requirements outlined in DOE/RL-2010-92 (Rev. 1), sampling frequency for all wells was established as semiannual for indicator parameters and field parameters, and annual for groundwater quality parameters. Site specific constituents, as identified in Chapter 3, will be monitored annually except for field parameters to be monitored during each sampling event.

The site has remained under detection monitoring for indicator parameters since 2010. Statistical analyses of the RCRA parameters used as indicators of groundwater contamination have not shown an exceedance since implementation of DOE/RL-2010-92 (Rev. 0). Thus, dangerous wastes subject to WAC 173-303 are not considered to have contaminated the groundwater beneath the 216-A-37-1 Crib.

RCRA groundwater monitoring activities at the 216-A-37-1 Crib currently sample from a network of 5 wells. Samples are analyzed semiannually for parameters used as indicators of groundwater contamination and annually for parameters establishing groundwater quality. Water level measurements are collected each time a sample is obtained from a network well. Site-specific constituents are also sampled annually. The network wells are included in the annual comprehensive March water level measurement campaign (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*). Groundwater monitoring results are summarized annually for the 216-A-37-1 Crib in the annual groundwater monitoring report.

2.6 Conceptual Site Model

Groundwater flow and contaminant transport strongly influence the groundwater monitoring strategy. Therefore, having a realistic CSM of hydrogeologic and contaminant conditions is necessary for development of a practical groundwater monitoring plan. A groundwater CSM is an evolving hypothesis that identifies important features, events, and processes that control groundwater and contaminant movement. This model is based on the results of previous geological and hydrogeological studies, and groundwater monitoring results (PNNL-11523 [Rev. 1], PNNL-12261, DOE/RL-2009-85, and annual groundwater monitoring reports).

This section describes the 216-A-37-1 CSM for potential contaminant transport to guide future groundwater monitoring. The CSM is shown in Figure 2-15. The CSM describes the current understanding of the contaminant release and transport and includes the following site characteristics and assumptions:

- Liquid wastes released in the crib migrated through the vadose zone and into the groundwater.
- As the mobile constituents in the vadose zone intercepted and mixed with groundwater in the unconfined aquifer, the constituents moved laterally with groundwater flow.
- The persistence of an isolated nitrate plume below the 216-A-37-1 Crib suggests a continuing source of nitrate contamination in the vadose zone. Increasing nitrate levels in surrounding wells upgradient of the crib indicates there is additional nitrate contribution from a diffuse nitrate mass migrating through the area.
- Groundwater contamination tends to be higher in concentration near the water table; thus, wells are most often screened (or casings perforated) near the water table (PNL-2724, *Vertical Contamination in the Unconfined Groundwater at the Hanford Site, Washington*).
- Groundwater flow, in more recent years, has reverted toward the flow pattern that existed before the large discharges to B Pond. A southeast to southward flow near the 216-A-37-1 Crib is indicated based on contaminant plume migration in the area and measurements obtained from adjacent wells comprising low gradient water table measurement network (Figure 2-8). The water table elevation in the 200 East Area has declined significantly since discharges to B Pond completely ceased in 1997. The rate of decline has decreased during the last 5 years. Wells in the area have shown a decrease in the water table elevation of only 0.07 to 0.15 m (0.2 to 0.5 ft) between 2010 and 2015.
- Near the 216-A-37-1 Crib, a large region of channel deposits comprised of Hanford formation and older CCU sediments extends across the southeastern portion of 200 East Area (Figure 2-15). Channel sediments fill an erosional scour that has removed a portion of the older Ringold Formation sediment (i.e., unit E and the Ringold lower mud unit north and northeast of the site (Figures 2-4, 2-5, and 2-6). Where the Ringold lower mud is present, it acts as a confining or semiconfining layer above the Ringold Formation unit A. North and northeast of the crib, the Cold Creek directly overlays sand and gravel of

the Ringold Formation unit A. Directly underlying the crib are sand and gravel of the Hanford formation and Cold Creek.

- Projected lithologic contacts suggest that the Ringold lower mud may partially confine the Ringold Formation unit A south of the 216-A-37-1 Crib (Figure 2-5).
- As shown in Figures 2-4, 2-5, and 2-6, hydraulic communication can occur between the uppermost unconfined Hanford and CCU and partially confined or unconfined sediments comprising the lower portions of the Ringold Formation.
- Hydraulic conductivity of Hanford and Cold Creek sediments are generally higher than that of Ringold units A or E. Although in some areas within 200 East, the hydraulic conductivity of the upper portion of the Ringold unit E appears similar to that of the Hanford and Cold Creek. Where these stratigraphic units are found laterally or vertically juxtaposed as the result of the depositional environment, contaminants may preferentially flow in the Hanford or Cold Creek versus Ringold units.
- Regionally, there is an upward hydraulic gradient within the confined Ringold aquifer. Groundwater flow may occur from the confined Ringold Formation unit A into the highly transmissive Hanford and Cold Creek channel-fill sediments in areas along the channel margins where these stratigraphic units are in contact.

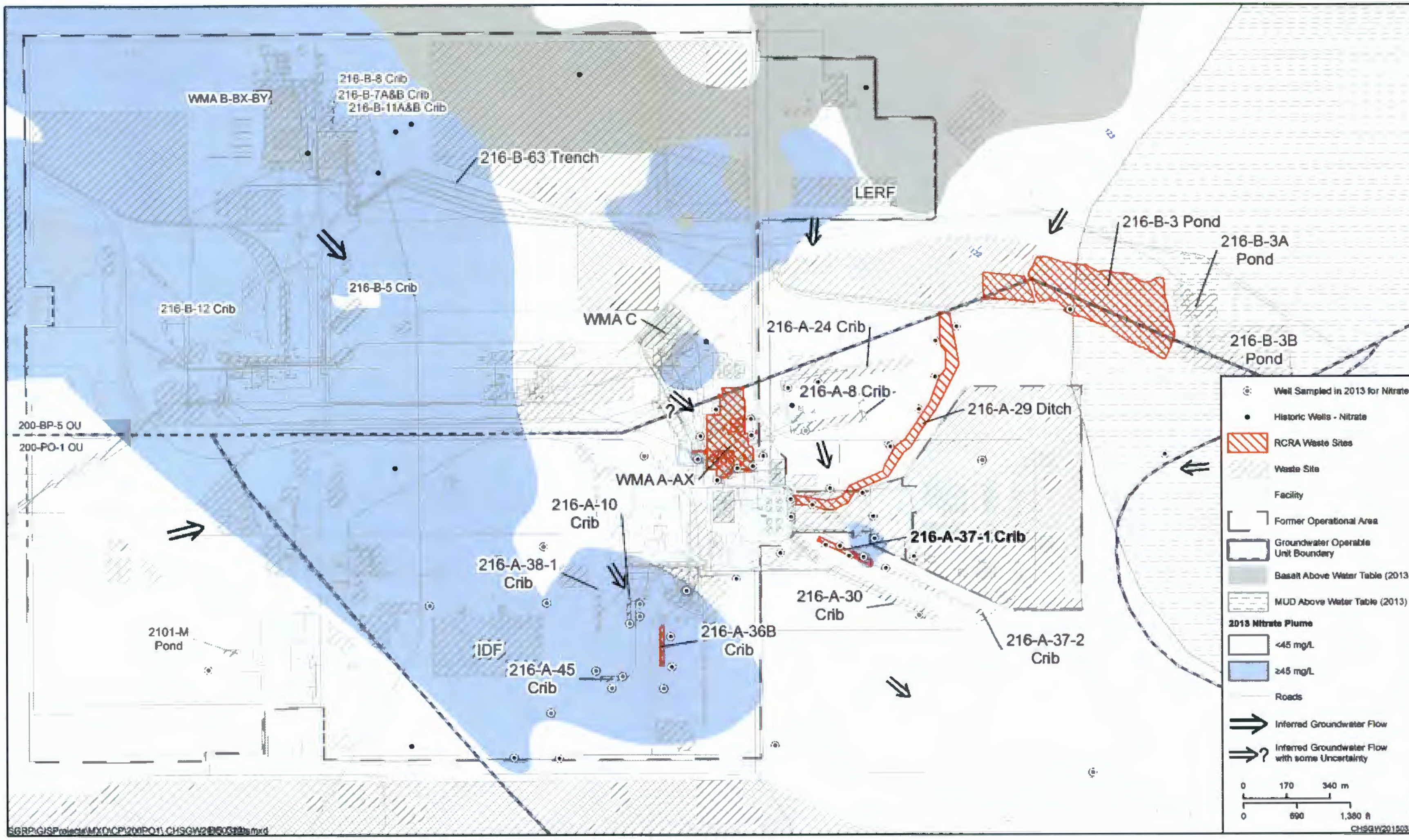


Figure 2-9. Distribution of Nitrate in 2013 at a Concentration above the 45 mg/L Drinking Water Standard in Vicinity of the 216-A-37-1 Crib

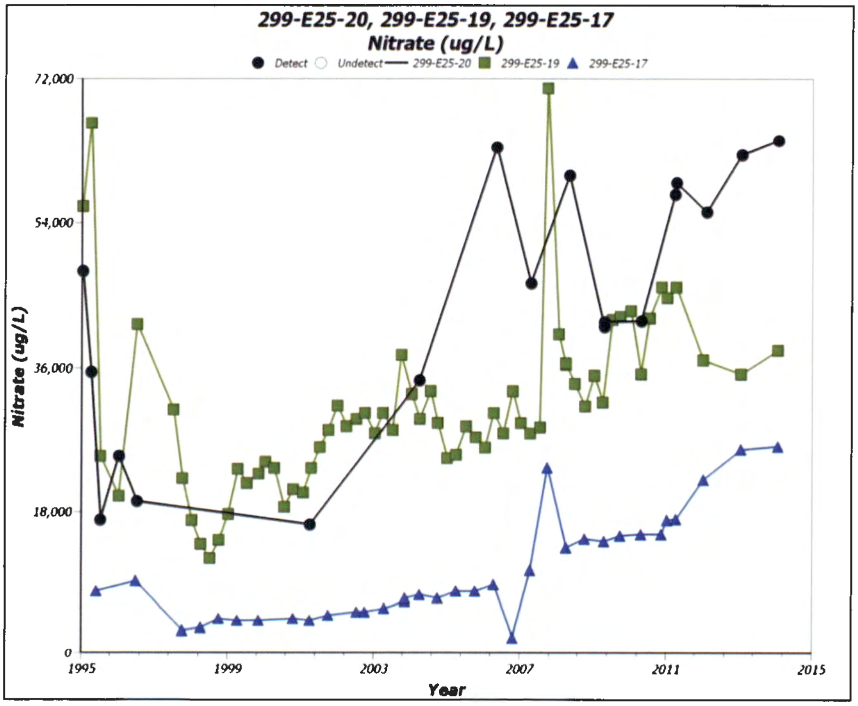


Figure 2-10. Time Series Plot Showing Changes in Nitrate Concentrations in Downgradient Monitoring Wells

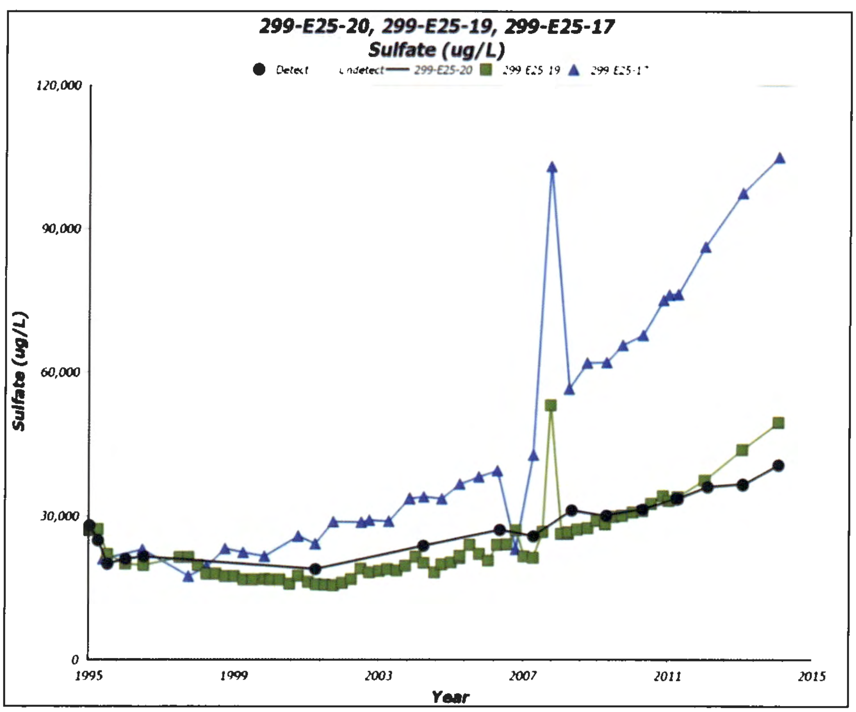


Figure 2-11. Time Series Plot Showing Changes in Sulfate Concentrations in Downgradient Monitoring Wells

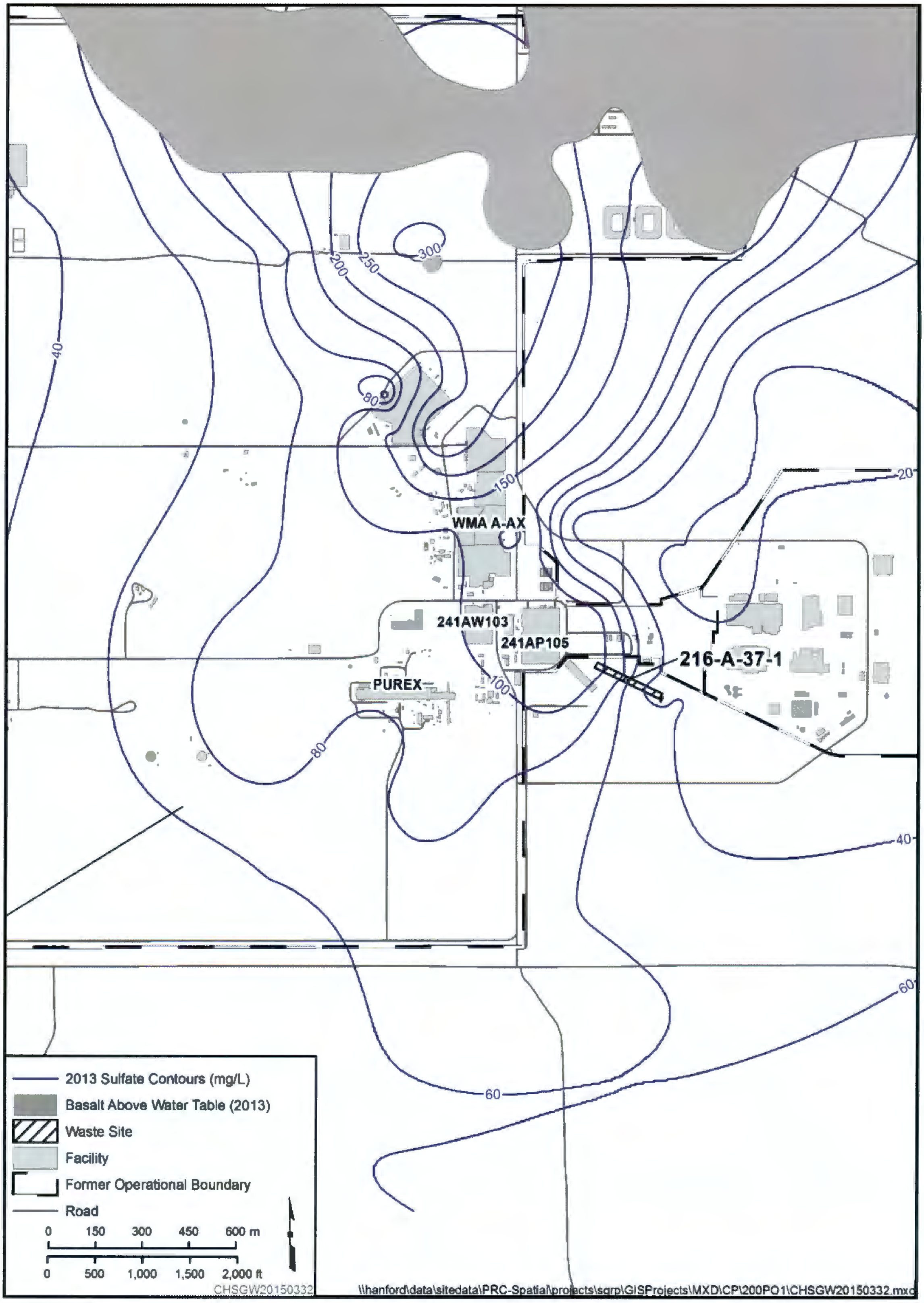


Figure 2-12. Contour Map of 2013 Sulfate Concentrations in the Vicinity of 216-A-37-1 Crib

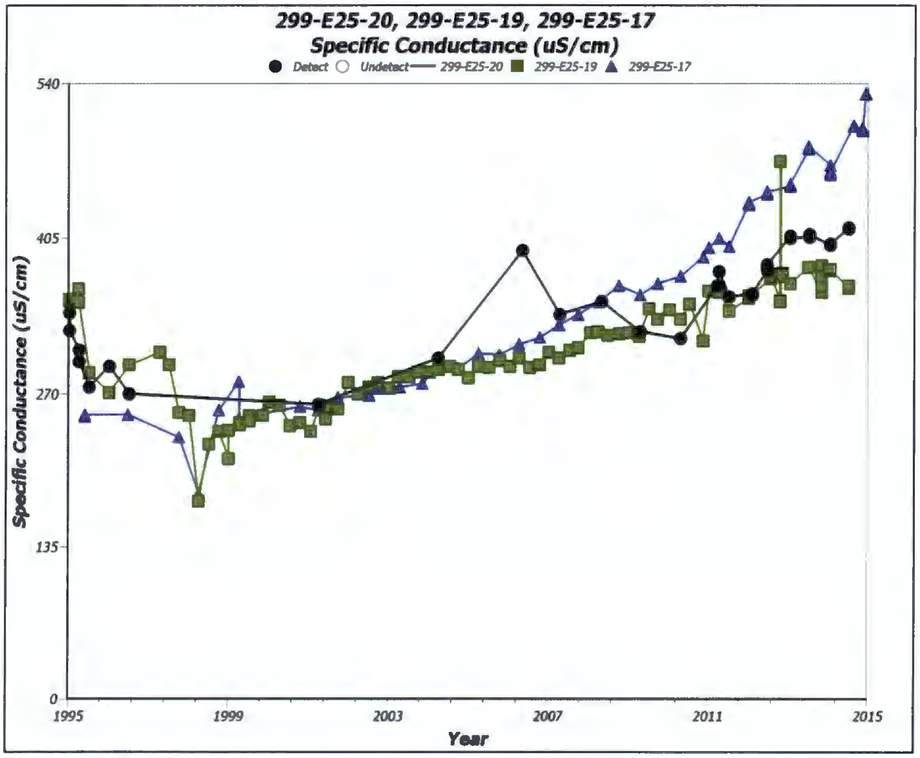


Figure 2-13. Time Series Plot Showing Increasing Conductivity Values in Downgradient Wells Associated with Upgradient Nitrate and Sulfate Contributions

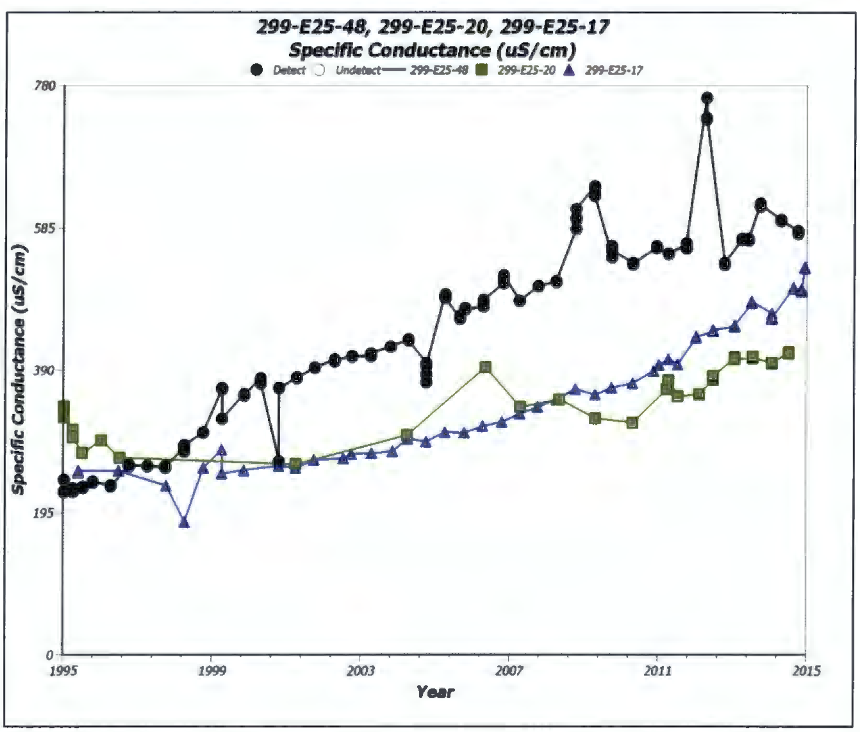


Figure 2-14. Time Series Plot Showing Increasing Conductivity Values in Upgradient Well 299-E25-48 and Downgradient Wells 299-E25-20 and 299-E25-17

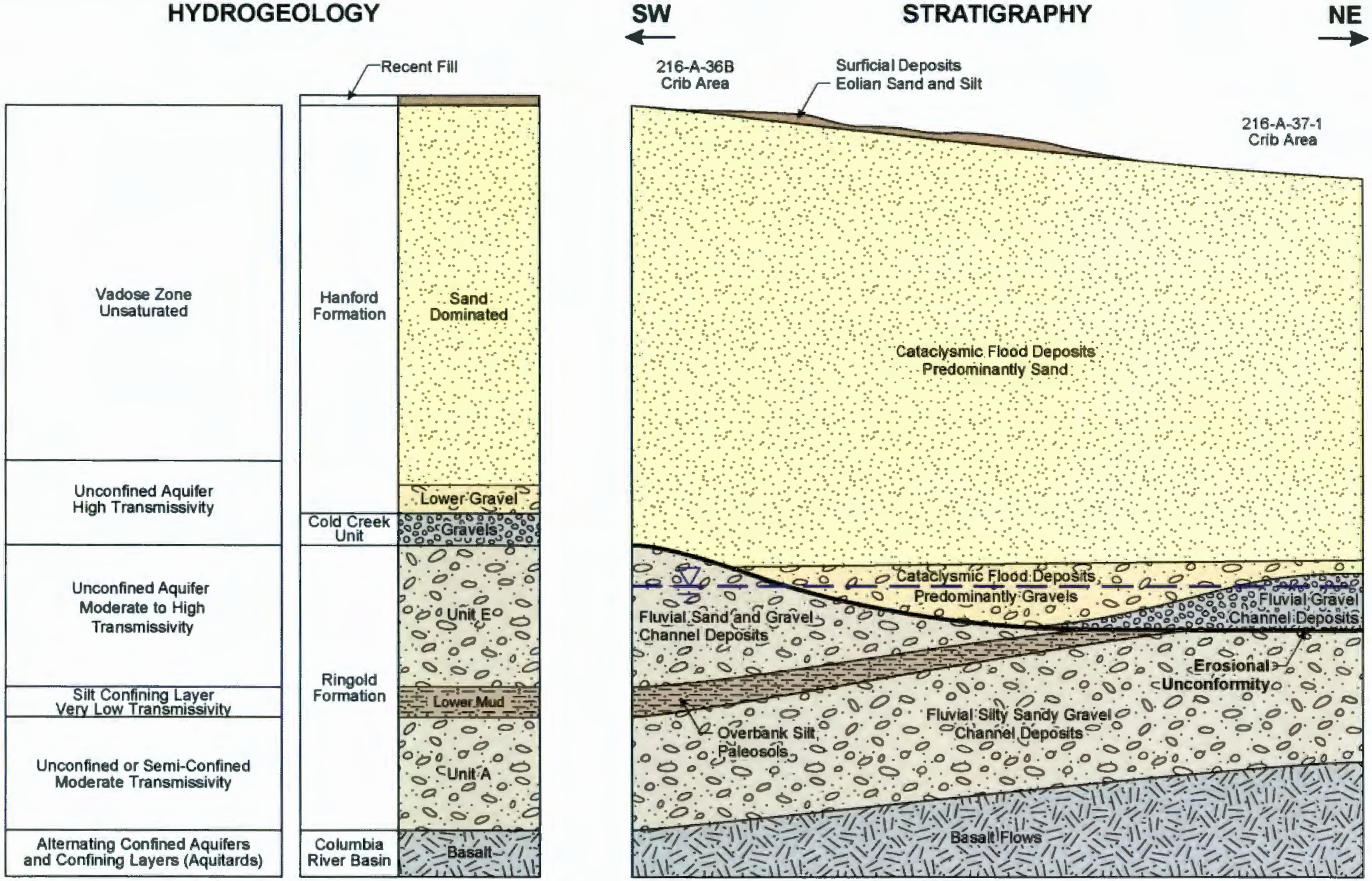


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Figure 2-15. Hydrogeologic Conceptual Model for the 216-A-37-1 Crib and Southeastern Portion of the 200 East Area

2.7 Monitoring Objectives

The groundwater monitoring program at the 216-A-37-1 Crib is conducted with the objectives of providing a program capable of determining the facility's impact, if any, on the quality of the underlying groundwater, and of complying with applicable RCRA requirements for interim status TSD units where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90 "Applicability" through 265.94, "Recordkeeping and Reporting." Table 2-3 identifies where each groundwater monitoring element of the pertinent applicable regulations is addressed within this plan. Additional anions and cations (Table 2-4) will also be collected for general groundwater chemistry, which will support the evaluation of upgradient and downgradient water chemistry variations (e.g., data used for Stiff diagrams and charge balance determinations).

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement Is Addressed in Monitoring Plan
Number and Location of Wells	40 CFR 265.91, "Ground-Water Monitoring System". (a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of: (1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are: (i) Representative of background ground-water quality in the uppermost aquifer near the facility; and (ii) Not affected by the facility; and (2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer.	Section 3.2
Well configuration	40 CFR265.91: (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand, where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water. Additional Requirements from WAC 173-303-400(3)(c)(v)(C), "Dangerous Waste Regulations," "Interim Status Facility Standards": Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells.	Section 3.2 and Appendix C

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement Is Addressed in Monitoring Plan
Parameters to be sampled Frequency of sampling Water-level measurements	40 CFR 265.92, "Sampling and Analysis": (b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section: (1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III.[b] (2) Parameters establishing ground-water quality: (i) Chloride (ii) Iron (iii) Manganese (iv) Phenols (v) Sodium (vi) Sulfate [Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under §265.93(d).] (3) Parameters used as indicators of ground-water contamination: (i) pH (ii) Specific conductance (iii) Total organic carbon (iv) Total organic halogen (c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. He must do this quarterly for one year. (2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year. (d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually. (2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semi-annually. (e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.	Section 3.1 and Appendix B, Section B2.2
Methods used to evaluate the	40 CFR 265.93, "Preparation, Evaluation, and Response": (b) For each indicator parameter specified in §265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least	Sections 4.1, 4.2, 4.3 and Appendix A

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement Is Addressed in Monitoring Plan
collected data and responses	four replicate measurements on each sample, for each well monitored in accordance with §265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background. (c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error. (d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality. (d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility.	
Recordkeeping and Reporting	40 CFR 265.94, "Recordkeeping and Reporting": (a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(b) throughout the active life of the facility (a)(2) Report the following ground-water monitoring information to the department: (ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.92(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.92(c)(1).	Section 4.5 Appendix A, Section A2.6

Note: The references cited in this table are listed in the reference section (Chapter 6) of this plan.

RCRA regulatory requirements for interim status TSD units where no impact to groundwater has been identified, are found in WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265.90, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are not listed because, in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis," these analyses are conducted only during the first year of monitoring.

Table 2-3. Pertinent RCRA Interim Status Facility Groundwater Monitoring Requirements

Groundwater Monitoring Element	Pertinent Requirement[a]	Section Where Requirement Is Addressed in Monitoring Plan

CFR = *Code of Federal Regulations*

RCRA = *Resource Conservation and Recovery Act of 1976*

TSD = treatment, storage, and disposal

Table 2-4. Additional Monitoring Objectives

Monitoring Objective	Site-Specific Constituents
Alkalinity Constituents – used in ion balance and to support water chemistry analysis.	Alkalinity
	Bicarbonate (from Alkalinity)
	Carbonate (from Alkalinity)
	Hydroxyl Ion
Metals – additional metals used in ion balance and to support water chemistry analysis.	Calcium
	Magnesium
	Potassium
Anions – additional anions used in ion balance and to support water chemistry analysis.	Fluoride
	Nitrate
	Nitrite
Field parameters provided information on water properties at the time of sampling	Temperature
	Turbidity

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3 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for the 216-A-37-1 Crib consisting of a monitoring well network, parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, and sampling and analysis protocols. The monitoring program presented herein has been revised from that presented in the previous plan (DOE/RL-2010-92, Rev. 1).

It should be noted that the 216-A-37-1 Crib is anticipated to be clean closed through an approved RCRA closure plan. Thus, after final closure, a RCRA groundwater monitoring plan will not be required. However, any past-practice contamination that may remain in the soil or groundwater will be addressed through the CERCLA remedial action process.

3.1 Constituents List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, the parameters analyzed as required for RCRA monitoring, and the sampling frequency for monitoring of the 216-A-37-1 Crib. Parameters used as indicators of groundwater contamination (pH, specific conductance, total organic carbon, and total organic halogen) will be sampled and analyzed semiannually (40 CFR 265.92[b][3] and [d][2]). Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, sulfate) will be sampled and analyzed annually (40 CFR 265.92[b][2] and [d][1]). Water level measurements at each monitoring well will be determined each time a sample is obtained (40 CFR 265.92[e]). Though not required by regulation, additional constituents will be monitored and are identified in Table 2-4. These constituents support analysis of general water chemistry in the upgradient and downgradient monitoring areas and can be used to support comparative analysis of general groundwater characteristics in the monitoring area.

Maintenance problems and sampling logistics sometime delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the specific times within a given month that a well is sampled. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sampling Management and Reporting group, along with the project scientist, consult on how best to recover or reschedule the sampling event as close to the original sampling date as possible. Missed sampling events that are not rescheduled within the same month are given top priority when rescheduling in the following month. Missed or cancelled sampling events are reported to DOE-RL, at the appropriate Unit Managers Meeting, and in the annual groundwater monitoring report.

3.2 Monitoring Well Network

Numerous groundwater wells exist in the vicinity of the 216-A-37-1 Crib. Not all wells meet WAC 173-160 construction standards. The following criteria were used to select wells for RCRA monitoring of the 216-A-37-1 Crib:

- Location of the downgradient wells with respect to the waste site boundary and groundwater flow path (wells closest to the waste site boundary were prioritized for use because they would provide the most immediate indication of a release)
- Well screen position with respect to the water table (wells constructed with screens positioned closest to the vadose zone/water table interface were preferred for indicating contaminant presence in groundwater resulting from a nearby waste site release)

- Suitable well construction such that the sampling data provided will be comparable with other network wells
- Compliance with WAC 173-160

The three downgradient wells used for monitoring the 216-A-37-1 Crib are considered appropriate for the monitoring objectives, but are not compliant with WAC 173-160 as resource protection wells suitable as RCRA standard or equivalent wells. Per agreement between DOE and Ecology, noncompliant wells are identified and placed on the prioritized drilling schedule for replacement consistent with site-wide cleanup priorities as described in Milestone M-024-58, which is contained in the Tri-Party Agreement Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*), as revised. The three downgradient wells have been included in this milestone for future replacement.

The previous 216-A-37-1 monitoring network consisted of one upgradient and three downgradient wells see (Figure 2-8). One upgradient well located north of the crib (299-E25-47) is no longer considered suitable by itself for monitoring the south-southeast groundwater flow and upgradient constituent concentrations. This upgradient well is being augmented with the addition of Well 299-E25-48 (which is compliant with WAC 173-160). Well 299-E25-48 is an existing downgradient well within the RCRA monitoring network of the nearby 216-A-29 Ditch; however, it is newly added to the 216-A-37-1 monitoring well network as an upgradient well. Wells 299-E25-47 and 299-E25-48 are located north and northwest, respectively, of the 216-A-37-1 Crib and will provide better coverage and representation of the upgradient groundwater constituents migrating to the south and southeast and impacting the site. Figure 3-1 presents the updated groundwater monitoring network to be utilized in this plan. Information on the wells comprising the updated network is summarized in Table 3-2.

Well 299-E25-48 is located south of the 216-A-29 Ditch and has been sampled since 1992. Specific conductance, nitrate, and sulfate levels have been consistently increasing in this well, as it has for other wells upgradient of the 216-A-37-1 crib and the 216-A-29 Ditch since 1998. Specific conductance levels in downgradient wells comprising the 216-A-37-1 well network are related to an encroaching sulfate plume (Figure 2-12) and a diffuse nitrate mass moving south to southeast through the monitoring area and to nitrate levels associated with the crib (Figure 2-9).

When a well is within approximately 2 years of going dry, a replacement well is proposed. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement (Ecology et al.,) Milestone M-24-00.

Construction details and pertinent information for the wells are provided in Appendix C. Some wells are co-sampled with other monitoring programs (e.g., monitored to meet CERCLA requirements). Monitoring requirements for those other monitoring programs are described in separate plans. The reported data from those other monitoring programs are supplementary to information gathered under this plan.

3.3 Differences between This Plan and Previous Plan

There are two differences between this plan and the previous plan. Monitoring Well 299-E25-48 has been added to the monitoring network to provide better representation of groundwater conditions upgradient of the 216-A-37-1 Crib (Table 3-3). All wells in the updated network have sufficient historical data such that no first year analyses are needed to establish background conditions. Analysis for the presence of VOCs was completed using the 216-A-37-1 downgradient wells in 2011, with no detections observed, the VOC sampling outlined in the previous plan has been removed from this plan.

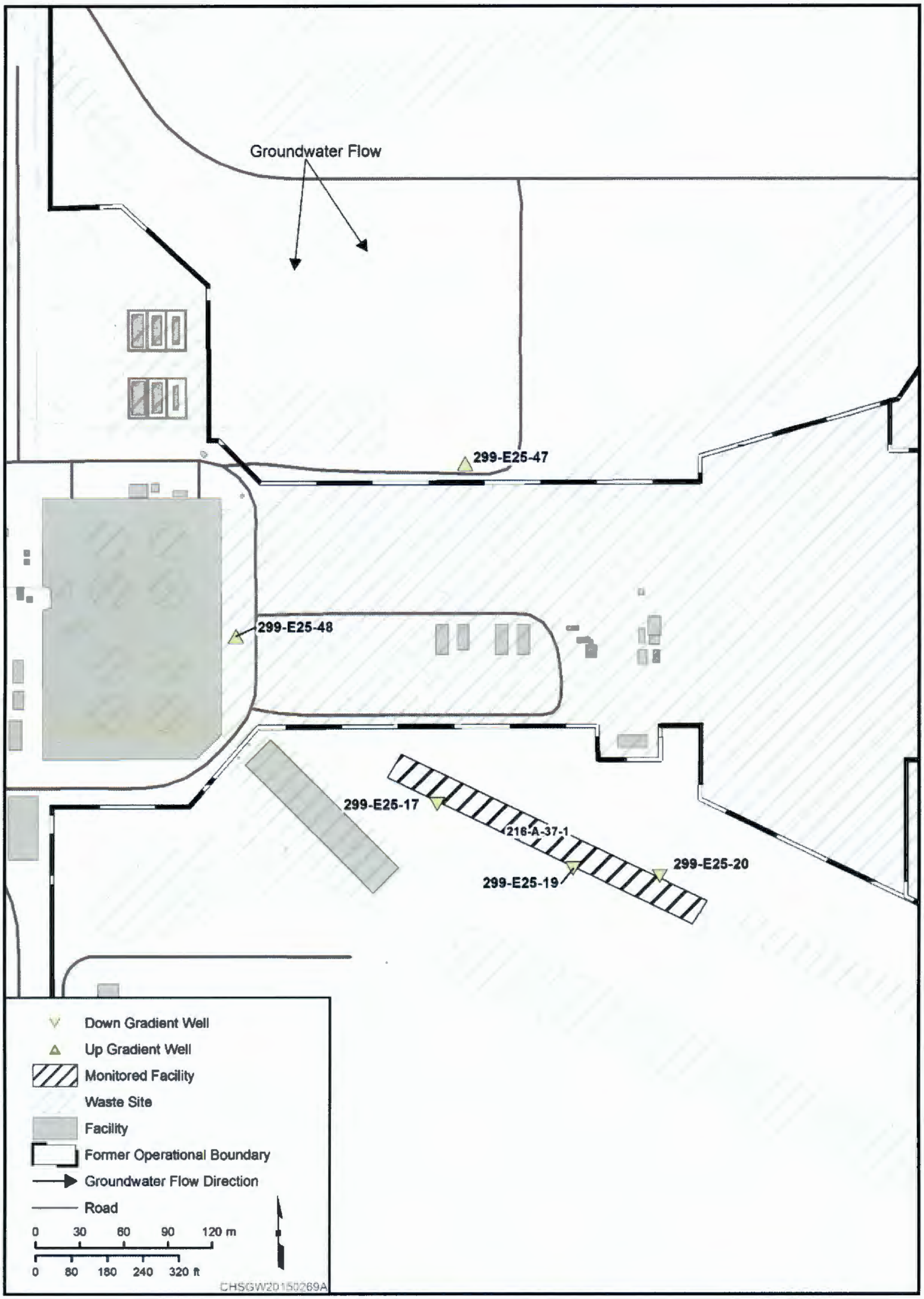

Figure 3-1. 216-A-37-1 RCRA Monitoring Well Network

Table 3-1. Monitoring Well Network for the 216-A-37-1 Crib

			RCRA Required Parameters[a]											Other			
				Contamination Indicator Parameters				Groundwater Quality Parameters						Site-Specific Constituents			
Well Name	**Purpose**	**WAC Compliant**	**Water Level**	**pH**	**Specific Conductance**	**Total Organic Carbon**	**Total Organic Halogen**	**Chloride**	**Iron (Filtered and Unfiltered)**	**Manganese (Filtered and Unfiltered)**	**Phenols**	**Sodium (Filtered and Unfiltered)**	**Sulfate**	**Alkalinity[b]**	**Metals (Filtered and Unfiltered)[c]**	**Anions[d]**	**Field Parameters[e]**
299-E25-47	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S
299-E25-48	Upgradient	Y	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S
299-E25-17	Downgradient	N[f]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S
299-E25-19	Downgradient	N[f]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S
299-E25-20	Downgradient	N[f]	S	S4	S4	S4	S4	A	A	A	A	A	A	A	A	A	S

a. Parameters required by 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis."

b. Alkalinity includes analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.

c. Includes analysis of calcium, magnesium, and potassium.

d. Includes analysis of fluoride, nitrate, and nitrite.

e. Includes temperature and turbidity.

f. Well identified for replacement consistent with sitewide cleanup priorities described in Milestone M-024-58 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*.

A = to be sampled annually
CFR = *Code of Federal Regulations*
N = well is not constructed as a resource protection well (WAC 173-160)
RCRA = *Resource Conservation and Recovery Act of 1976*
S4 = to be sampled semiannually, with quadruplicate samples collected during each event
S = to be sampled semiannually
WAC = *Washington Administrative Code*
Y = well is constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

Table 3-2. Attributes for Wells in the 216-A-37-1 Groundwater Monitoring Network

Well Name	Completion Date	Easting[a] (m)	Northing[a] (m)	Screen Top (m [ft] bgs)[b] and *Elevation (m)*[c]	Screen bottom (m [ft] bgs)[b] and *Elevation (m)*[c]	Water Depth (m [ft] bgs)[b] and *Elevation (m)*	Remaining Water Column (m[ft])	Water Table Measurement Date
299-E25-47[d]	1992	575778.953	135931.544	80.2 (263) *125.196*	86.3 (283.2) *119.039*	83.6 (274.3) *121.822*	2.78 (8.12)	1/9/2015
299-E25-48[d]	1992	575623.851	135815.69	83.6 (274.3) *124.577*	89.8 (294.6) *118.389*	86.4 (283.5) *121.778*	3.38 (11.1)	10/3/2014
299-E25-17	1976	575760.245	135702.51	83.2 (273) *123.457*	90.0 (295) *116.657*	84.9 (278.5) *121.757*	5.1 (16.7)	12/12/2014
299-E25-19	1976	575852.333	135659.027	82.3 (270) *124.609*	90.0 (295) *116.909*	85.2 (279.6) *121.709*	4.8 (15.7)	12/22/2014
299-E25-20	1976	575910.942	135654	82.0 (269) *124.688*	89.6 (294) *117.088*	85.0 (279.0) *121.688*	4.6 (14.96)	7/11/2014

a. Coordinates are in NAD83, *North American Datum of 1983*.

b. bgs = below ground surface

c. Coordinates are in NAVD88, *North American Vertical Datum of 1988*.

d. Upgradient well

Table 3-3. Main Differences Between this Monitoring Plan and Previous Monitoring Plan

Type of Change	Previous Plan[a]	Current Plan	Justification Summary
Constituents	Indicator Parameters, Groundwater Quality Parameters, Water Chemistry Constituents, Site Specific Constituents[b]	Indicator parameters, groundwater quality parameters, water chemistry constituents, site specific constituents	Removal of volatile organic compound sampling from site specific constituent list as it was completed under previous plan
Sampling Frequency	Indicator Parameters (Semiannual), Groundwater Quality Parameters (Annual), Water Level Measurements (Every Sampling Event), Additional Constituents (Annual), Field Parameters (Semiannual)	Same	No change
Well Network	One Upgradient Well, Three Downgradient Wells	Two upgradient wells, three downgradient wells	Additional upgradient monitoring well (299-E25-48) added as two upgradient wells are needed to monitor current spatial variability in upgradient constituent concentrations impacting the site
Groundwater Flow Direction	South to Southeast	Same	No change
Type of Groundwater Monitoring Program	Indicator Evaluation Program	Same	No change
Background Arithmetic Mean Recalculated	Calculated Annually Using One Upgradient Well	Calculated annually using two upgradient wells	Two wells (299-E25-47 and 299-E25-48) are needed to capture spatial variability in upgradient conditions. Calculated annually using EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*.
Groundwater Quality Assessment Plan Outline	None[c]	Updated outline provided in Chapter 5.	Updated outline made available within document

a. DOE/RL-2010-92, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-37-1 PUREX Plant Crib*.

b. Specifically, volatile organic compounds listed as a supporting constituent in the previous plan for first year analysis only.

c. Outline developed and accessible in project file.

3.4 Sampling and Analysis Protocol

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units. The QAPjP outlining the project management structure, data generation and acquisition, analytical procedures, and quality control is provided in Appendix A. Appendix B provides the sampling protocols (e.g., sampling methods, sample handling and custody, management of waste, and health and safety considerations).

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4 Data Evaluation and Reporting

This chapter discusses the evaluation, and interpretation of data.

4.1 Data Review

The data review and verification are discussed in the QAPjP (Appendix A).

4.2 Statistical Evaluation

The goal of the RCRA groundwater monitoring indicator evaluation program is to determine if the 216-A-37-1 Crib operations have affected groundwater quality beneath the site, which is determined based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, total organic carbon, and total organic halogen) to background levels to test for potential impact to groundwater. Each time a monitoring well is sampled, four replicate samples for total organic carbon and total organic halogen are collected, and four replicate field measurements are made for pH and specific conductance.

The basic procedure for statistical comparisons is as follows: twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored, and then compare these results with the background arithmetic mean obtained (40 CFR 265.92[c][2]) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over background (40 CFR 265.93[b]). Implementation of the statistical test method at the Hanford Site, including at 216-A-37-1, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing groundwater flow conditions due to groundwater remedial actions currently being implemented at the Hanford Site.

If a comparison for a downgradient well shows a significant increase (or pH decrease), then the well is resampled. For total organic carbon and total organic halogen, split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notifications are made as detailed in Section 4.5 and in accordance with 40 CFR 265.

4.3 Interpretation

Data are used to interpret groundwater conditions at the 216-A-37-1 Crib. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.

- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential on the maps.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

4.4 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the network to determine if it remains adequate to monitor the facility's impact on the quality of the groundwater in the uppermost aquifer underlying the facility (40 CFR 265.93[f]). The network must include at least one upgradient and at least three downgradient wells in the uppermost aquifer (40 CFR 265.91[a][1] and [2]).

The current groundwater monitoring network will continue to be re-evaluated to ensure that it is adequate to monitor the any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the 216-A-37-1 CSM and geochemical trends will be re-evaluated to determine network efficiency and any necessary modification requirements for the network.

Water- level measurements will continue to be collected before each sampling event. An additional and more comprehensive set of water -level measurements is made annually for selected wells on the Hanford Site, and the data are presented in the annual groundwater monitoring reports.

4.5 Reporting and Notification

Groundwater monitoring results are reported annually in accordance with the requirements of 40 CFR 265.94. Reporting will be made in the annual groundwater monitoring reports.

If a comparison for an upgradient well shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported in the annual groundwater monitoring report.

If the exceedance of the statistical comparison value is confirmed, written notice is then provided to Ecology within 7 days (40 CFR 265.93[d][1]) stating that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program must be developed and submitted to Ecology (40 CFR 265.93[d][2] and WAC 173-303-400[3][c][v][D]). In some instances, it is possible to determine immediately that the statistical finding is not the result of contamination from the facility. In that case, Ecology is notified, and a groundwater quality assessment program is not instituted.

5 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value or if pH decreases and is confirmed by verification sampling, a detailed assessment plan will be prepared and submitted to Ecology and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, their rate and extent of migration and their concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline required by 40 CFR 265.93(a). An outline for the assessment plan is presented in Table 5-1. The groundwater quality assessment program may include the following elements:

- Description of the hydrogeologic conditions and identification of potential contaminant pathways
- Description of the investigative approach for making first determination to decide if dangerous waste or dangerous waste constituents from the facility have entered the groundwater or if the exceedance was caused by other sources (false positive rationale)
- Description of the approach to fully characterize rate and extent of contaminant migration
- Number, locations, and depths of wells in the monitoring network
- Sampling and analytical methods used
- Data evaluation methods
- An implementation schedule

The results of assessment determinations will be made as soon as technically feasible and a report of the findings will be sent to Ecology. The determinations will then be updated annually as required by 40 CFR 265.94(b).

Table 5-1. Revised Groundwater Quality Assessment Plan Outline

- Introduction
- Background
    - Facility Description and Operational History
    - Regulatory Basis
    - Waste Characteristics
    - Geology and Hydrogeology
    - Summary of Previous Groundwater Monitoring and Results
    - Conceptual Site Model
    - Monitoring Objectives
- Groundwater Monitoring
    - Constituent List and Sampling Frequency
    - Well Network
    - Sampling and Analysis Protocol
- Data Evaluation and Reporting
    - Evaluation of Dangerous Waste Constituents
    - Interpretation
    - Annual Determination of Monitoring Network
    - Reporting and Notification
- References
- Appendix A – Quality Assurance Project Plan
- Appendix B – As-Built Drawings of Wells in Well Network

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265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

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Appendix A

Quality Assurance Project Plan

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Contents

Tables

Figure

Terms

CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	data quality assessment
DQI	data quality indicator
EB	equipment blank
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FWS	Field Work Supervisor
GC/MS	gas chromatography/mass spectrometry
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
HEIS	Hanford Environmental Information System
ICP	inductively coupled plasma
LCS	laboratory control sample
MDL	method detection limit
MB	method blank
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
PQL	practical quantitation limit
PS	post digestion spike
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	request for data review

RPD	relative percent difference
SAF	Sampling Authorization Form
S&GRP	Soil and Groundwater Remediation Project
SMR	Sample Management and Reporting
SPLIT	field split
SUR	surrogate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection requirements and controls based on the quality assurance (QA) elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD). Sections 6.5 and 7.8 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*) require QA, quality control (QC) and sampling and analysis activities to specify QA requirements for treatment, storage, and disposal (TSD) units, as well as for past practice processes. This QAPjP also describes the applicable requirements and controls based on guidance found in Washington State Department of Ecology (Ecology) Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*, and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5). This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to the 216-A-37-1 Crib groundwater monitoring activities: Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Review and Usability.

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A2 Project Management

This chapter addresses the management approaches planned, project goals, and planned output documentation.

A2.1 Project/Task Organization

The contractor, or its approved subcontractor, is responsible for planning, coordinating, sampling, and shipping samples to the laboratory. The contractor is also responsible for preparing and maintaining configuration control of the groundwater monitoring plan and assisting the U.S. Department of Energy (DOE)-Richland Operations Office (RL) project manager in obtaining approval of the groundwater monitoring plan and future proposed revisions. Project organization (regarding routine groundwater monitoring) is described in the following sections and illustrated in Figure A-1.

A2.1.1 DOE-RL Project Manager

Hanford Site cleanup is the responsibility of DOE-RL. The DOE-RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, *Resource Conservation and Recovery Act of 1976* (RCRA), *Atomic Energy Act of 1954*, and Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*) for the Hanford Site.

A2.1.2 DOE-RL Technical Lead

The DOE-RL technical lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to the DOE-RL project manager.

A2.1.3 Soil and Groundwater Remediation Project Manager

The Soil and Groundwater Remediation Project (S&GRP) manager provides oversight for all activities and coordinates with DOE-RL and primary contractor management in support of sampling and reporting activities. The S&GRP manager also provides support to the S&GRP RCRA groundwater manager to ensure that work is performed safely and cost effectively.

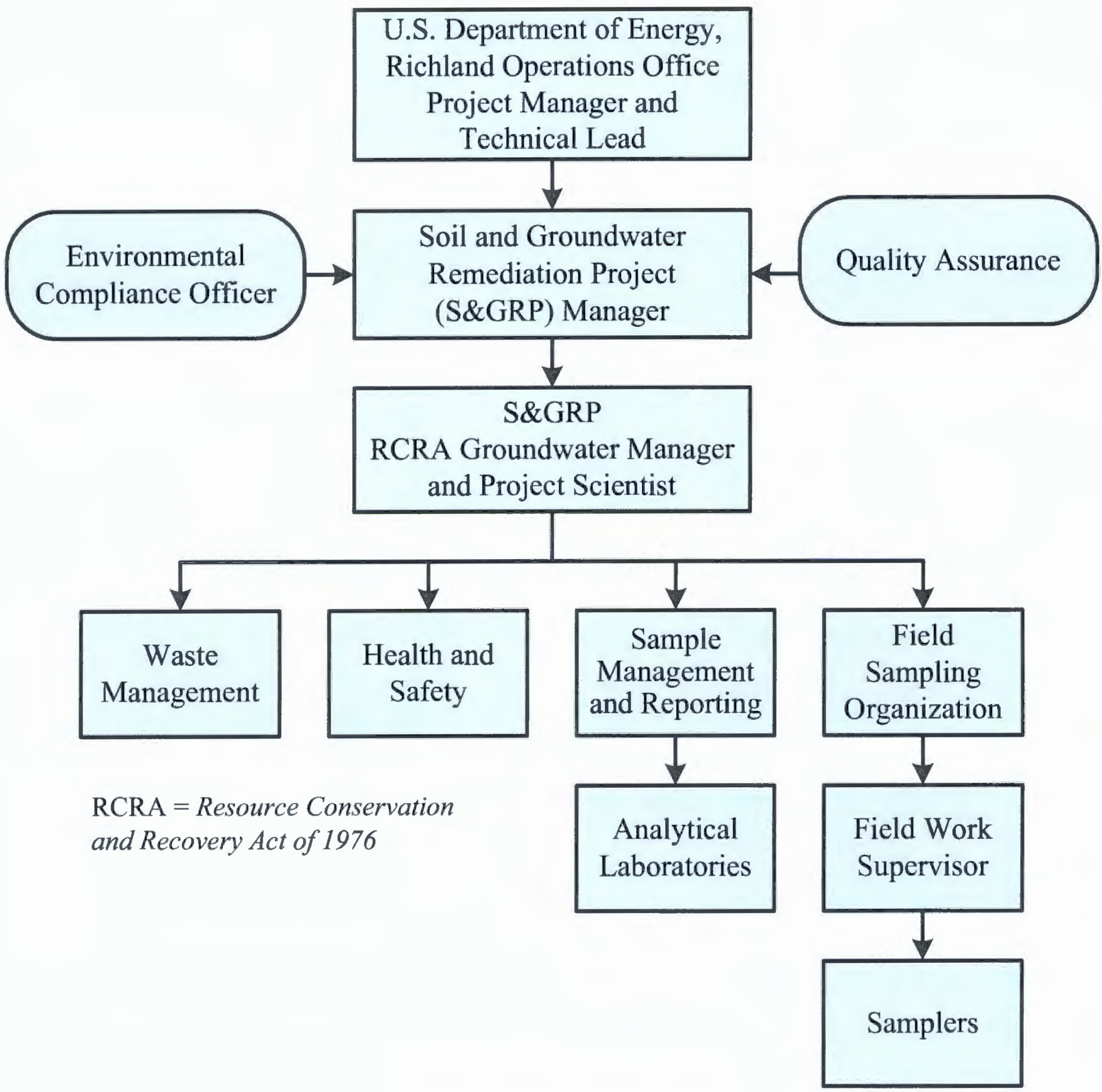

Figure A-1. Project Organization

A2.1.4 S&GRP RCRA Groundwater Manager

The S&GRP RCRA groundwater manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The S&GRP RCRA groundwater manager coordinates with, and reports to, DOE-RL and primary contractor management regarding RCRA TSD monitoring requirements. The S&GRP RCRA groundwater manager (or delegate) works closely with the Environmental Compliance Officer (ECO), QA, Health and Safety, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The S&GRP RCRA groundwater manager assigns scientists to provide technical expertise.

A2.1.5 Sample Management and Reporting Group

The SMR group coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan. The SMR group generates field sampling documents, labels, and instructions for field sampling personnel and develops the Sampling Authorization Form (SAF), which provides information and instruction to the analytical laboratories. The SMR group receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with the Field Sampling Organization, laboratories, or other entities. The SMR group is responsible for informing the S&GRP RCRA groundwater manager of any issues reported by the analytical laboratories.

A2.1.6 Field Sampling Organization

The Field Sampling Organization is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the nuclear chemical operators (samplers), who collect groundwater samples in accordance with this groundwater monitoring plan and in accordance with corresponding standard procedures and work packages. The FWS ensures that samplers are appropriately trained and available. The samplers collect all salient samples in accordance with sampling documentation. The samplers also complete field logbooks and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

In addition, pre-job briefings are conducted by the Field Sampling Organization, in accordance with work management and work release requirements, to evaluate activities and associated hazards by considering the following various factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required

A2.1.7 Quality Assurance

The QA point of contact is responsible for addressing QA issues on the project and overseeing implementation of the project QA requirements. Responsibilities include reviewing project documents, including the QAPjP, and participating in QA assessments on sample collection and analysis activities, as appropriate.

A2.1.8 Environmental Compliance Officer

The ECO provides technical oversight, direction, and acceptance of project and subcontracted environmental work and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

A2.1.9 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or by internal primary contractor work requirements.

A2.1.10 Waste Management

Waste Management is responsible for identifying waste management sampling/characterization requirements, to ensure regulatory compliance, and interpreting data to determine waste designations and profiles. Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost effective manner.

A2.1.11 Analytical Laboratories

The analytical laboratories analyze samples, in accordance with established procedures and the requirements of this plan, and provide necessary data packages containing analytical and QC results. The laboratories provide explanations of results to support data review and in response to resolution of analytical issues. The laboratories are evaluated under the DOE Consolidated Audit Program and must be accredited by Ecology for the analyses performed for S&GRP.

A2.2 Problem Definition/Background

The purpose to this groundwater monitoring plan is to satisfy the requirements of WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," Specifics on the activities to satisfy the requirements are provided in the main body of the monitoring plan including in Chapter 1.0 and Sections 2.7, 3.1, 3.2, and 4.2. Background information on monitoring is also provided in the main body of this plan including in Sections 2.2, 2.5 and 3.3.

A2.3 Project/Task Description

The project description is provided in Chapters 2, 3, and 4 of this monitoring plan and includes the parameter indicators as required by 40 CFR 265.92 for establishing groundwater quality and groundwater contamination detection, evaluation of the monitoring network, interpretation of analytical results, and reporting. The parameter indicators to be monitored, along with the monitoring wells and frequency of sampling, are provided in Chapter 3. Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B. In addition to the required parameter indicators of 40 CFR 265.92, a selection of added dangerous waste or dangerous waste constituents to be monitored is included in Chapter 3.

A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is to ensure that the generation of analytical data of known and appropriate quality is acceptable and useful in order to meet the evaluation requirements stated in the monitoring plan. In support of this objective, statistics and data descriptors known as data quality indicators (DQIs) are used to help determine the acceptability and utility of data to the user. The principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

Data quality is defined by the degree of rigor in the acceptance criteria assigned to the DQIs. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during the data quality assessment (DQA) process (Section A5.3).

Table A-1. Data Quality Indicators

DQI	Definition	Determination Methodologies	Corrective Actions
Precision	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/ replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use
Accuracy	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. Quality control analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use • Request reanalysis or re-measurement
Representativeness	Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for them not being representative • Flag for further review • Review data for usability • If data are usable, qualify the data for limited use and define the portion of the system that the data represent • If data are not usable, flag as appropriate • Redefine sampling and measurement requirements and protocols • Resample and reanalyze, as appropriate

Table A-1. Data Quality Indicators

DQI	Definition	Determination Methodologies	Corrective Actions
Comparability	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability
Completeness	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future completeness
Bias	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (MS).	For sampling bias: • Properly select and use sampling tools • Institute correct sampling and subsampling procedures to limit preferential selection or loss of sample media • Use sample handling procedures, including proper sample preservation, that limit the loss or gain of constituents to the sample media • Analytical data that are known to be affected by either sampling or

Table A-1. Data Quality Indicators

DQI	Definition	Determination Methodologies	Corrective Actions
			analytical bias are flagged to indicate possible bias. • Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other labs for analysis.
Sensitivity	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or re-measurement using methods or analytical conditions that will meet required detection or limit of quantitation • Qualify/reject the data before use

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, as amended.

DQI = data quality indicator

MS = matrix spike

QA = quality assurance

A2.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting groundwater samples according to the dangerous waste training plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Dangerous Waste Regulations," "Personnel Training." The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Training has been instituted by the contractor management team to meet training and qualification programs to satisfy multiple training drivers imposed by the applicable CFR and WAC requirements. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely.

Training records are maintained for each employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management confirms that an employee's training is appropriate and up-to-date prior to performing any field work.

A2.6 Documents and Records

The S&GRP RCRA groundwater manager (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Changes to elements of the monitoring plan that are required by 40 CFR 265.92 are not allowed, except as unintentional changes as described in Table A-2.

Table A-2. Change Control for Monitoring Plans

Type of Change*	Action	Documentation
Temporary addition of wells or other constituents, or increased sampling frequency that do not impact the requirements of 40 CFR 265.92.	S&GRP RCRA groundwater manager approves temporary change; provides informal notice to Ecology.	SMR group's integrated groundwater monitoring schedule
Unintentional impact to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, and loss of samples in transit.	S&GRP RCRA groundwater manager provides electronic notification to DOE-RL.	Annual groundwater monitoring report
Planned change to groundwater monitoring activities, including addition or deletion of supporting constituents, change of sampling frequency for supporting constituents, or changes to well network.	S&GRP RCRA groundwater manager obtains DOE-RL approval; revise monitoring plan.	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells).	S&GRP RCRA groundwater manager provides electronic notification to DOE-RL; revise monitoring plan.	Annual groundwater monitoring report and revised RCRA groundwater monitoring plan

Note: 40 CFR 265.93, "Preparation, Evaluation, and Response," contains additional sampling and notification requirements should indicator parameter results demonstrate a significant increase (or pH decrease).

* "Other constituents" are any constituents that may be included in this monitoring plan as additional analytes that are not required by 40 CFR 265.92, "Sampling and Analysis".

CFR = *Code of Federal Regulations*
DOE-RL = U.S. Department of Energy, Richland Operations Office
Ecology = Washington State Department of Ecology
RCRA = *Resource Conservation and Recovery Act of 1976*
S&GRP = Soil and Groundwater Remediation Project
SMR = Sample Management and Reporting

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The FWS, SMR, and any field crew supervisors are responsible for ensuring that field instructions are maintained and aligned with any revisions or approved changes to the groundwater monitoring plan.

The SMR group will ensure that any deviations from the plan are reflected in revised field sampling documents for the samplers and analytical laboratory. The FWS or appropriate field crew supervisors will ensure that deviations from the plan or problems encountered in the field are documented appropriately (e.g., in the field logbook).

The S&GRP RCRA groundwater manager, FWS, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities. The S&GRP RCRA groundwater manager is also responsible for ensuring that project files are setup, as appropriate, and/or maintained. The project files will contain project records or references to their storage locations. Project files generally include, as appropriate, the following information:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy will be provided to the SMR group)
- Inspection or assessment reports and corrective action reports
- Field summary reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract

The following records are managed and maintained by SMR personnel:

- Field sampling logbooks
- Groundwater sample reports and field sample reports
- Chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by offsite analytical laboratories

The laboratory is responsible for maintaining, and having available upon request, the following items:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Convenience copies of laboratory analytical results are kept in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hard copy format (e.g., DOE Records Holding Area). Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

Results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in the annual groundwater monitoring reports.

A3 Data Generation and Acquisition

This chapter addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

A3.1 Analytical Method Requirements

Analytical method requirements, for samples collected are presented in Table A-3. Updated U.S. Environmental Protection Agency (EPA) methods may be substituted for analytical methods identified in Table A-3.

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable PQL[b] (µg/L)
Groundwater Quality Parameters (40 CFR 265.92[b][2])		
Chloride	EPA/600 Method 300.0	400
Sulfate		550
Iron	SW-846 Method 6010B/C	50
Manganese		5
Sodium		500
Phenols	SW-846 Method 8270D	5
Contamination Indicator Parameters (40 CFR 265.92[b][3])		
pH	Field measurement Instrument/meter	N/A
Specific Conductance		N/A
Total Organic Carbon	SW-846 Method 9060	1,000
Total Organic Halogen	SW-846 Method 9020	10
Site-Specific Constituents[c]		
Alkalinity	EPA/600 Method 310.1 or Standard Method 2320	5,000
Bicarbonate alkalinity		-[d]
Carbonate alkalinity		-[d]
Hydroxide alkalinity		-[d]
Fluoride	EPA/600 Method 300.0	500
Nitrate		250
Nitrite		250
Calcium	SW-846 Method 6010B/C	1,000

Table A-3. Analytical Requirements for Groundwater Analysis

Constituent	Analytical Method[a]	Highest Allowable PQL[b] (µg/L)
Magnesium		750
Potassium		4,000
Temperature	Field Measurement Instrument/Meter	N/A
Turbidity		N/A

Reference: 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis"

Note: The information in this table does not represent EPA requirements but is intended solely as guidance.

a. For EPA Method 300.0, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Equivalent methods may be substituted.

b Highest allowable practical quantitation limits are specified in contracts with analytical laboratories. Actual quantitation limits vary by laboratory and may be lower than required contractually. Method detection limits are three to five times lower than quantitation limits.

c. Site-specific constituents are not required by RCRA but are used to support interpretation.

d. Constituent concentration is calculated from alkalinity and does not have an individual practical quantitation limit.

CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PQL = practical quantitation limit
RCRA = Resource *Conservation and Recovery Act of 1976*

A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with HASQARD (DOE/RL-96-68) requirements (as applicable). Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides the parameters identified for field measurements.

A3.3 Quality Control

QC requirements specified in the plan must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC sample requirements are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in HEIS, as appropriate.

Table A-4. Project Quality Control Requirements

Sample Type	Frequency	Characteristics Evaluated
Field Quality Control		
Field Duplicates	One in 20 well trips	Precision, including sampling and analytical variability
Field Splits	As needed When needed, the minimum is one for every analytical method, for analyses performed where detection limit and precision and accuracy criteria have been defined in the Analytical Performance Requirements (Table A-3)	Precision, including sampling, analytical, and interlaboratory
Full Trip Blanks	One in 20 well trips	Cross-contamination from containers or transportation
Equipment Blanks	As needed If only disposable equipment is used or equipment is dedicated to a particular well, then an EB is not required Otherwise, one for every 20 samples[a]	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment
Analytical Quality Control[b]		
Laboratory Duplicates	1 per analytical batch[c]	Laboratory reproducibility and precision
Matrix Spikes	1 per analytical batch[c]	Matrix effect/laboratory accuracy
Post-Preparation Spike	1 per analytical batch[c]	Matrix effect/laboratory accuracy
Matrix Spike Duplicates	1 per analytical batch[c]	Laboratory accuracy and precision
Laboratory Control Samples	1 per analytical batch[c]	Laboratory accuracy
Method Blanks	1 per analytical batch[c]	Laboratory contamination
Surrogates	1 per analytical batch[c]	Recovery/yield

Note: The information in this table does not represent EPA requirements but is intended solely as guidance.

a. For portable pumps, equipment blanks are collected one for every 10 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. Batching across projects is allowed for similar matrices (e.g., all Hanford groundwater).

c. Unless not required by, or different frequency is called out in, laboratory analysis methods.

EPA = U.S. Environmental Protection Agency

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analysis	Quality Control	Acceptance Criteria	Corrective Action
General Chemical Analyses			
Alkalinity (includes bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity)	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate	≤ 20% RPD[b]	Data reviewed[a]
	MS	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Total Organic Carbon	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Total Organic Halogen	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS and MSD	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Anions			
Anions by IC (Chloride, Fluoride, Nitrate, Nitrite, and Sulfate)	MB	< MDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	Laboratory Duplicate or MS/MSD	≤ 20% RPD[b]	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery	Flagged with "N"
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analysis	Quality Control	Acceptance Criteria	Corrective Action
Metals			
ICP-AES Metals (Calcium, Iron, Magnesium, Manganese, Potassium, and Sodium)	MB	< RDL < 5% Sample concentration	Flagged with "C"
	LCS	80–120% recovery	Data reviewed[a]
	MS or PS, and MSD	75–125% recovery	Flagged with "N"
	MS/MSD	≤ 20% RPD	Data reviewed[a]
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"
Semivolatile Organic Compounds			
Phenols by GC or GC/MS	MB	< MDL < 5% sample concentration	Flagged with "B"
	LCS	Statistically derived[c]	Data reviewed[a]
	MS and MSD	%Recovery statistically derived[c]	Flagged with "T" if analyzed by GC/MS, otherwise "N" based on FEAD
	MS/MSD	%RPD statistically derived[c]	Data reviewed[a]
	SUR	Statistically derived[c]	Data reviewed[a]
	EB, FTB	< 2 times MDL	Flagged with "Q"
	Field Duplicate	≤ 20% RPD[b]	Flagged with "Q"

Note:

The information in this table does not represent EPA requirements but is intended solely as guidance.

This table only applies to laboratory analyses. Specific conductance, pH, temperature, and turbidity are not listed as they are measured in the field.

a. After review, corrective actions are determined on a case-by-case basis.

b. Applies only in cases where both results are greater than 5 times the method detection limit.

c. Determined by the laboratory based on historical data or statistically derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those acceptance criteria may be used in place of statistically derived acceptance criteria.

EB = equipment blank
EPA = U.S. Environmental Protection Agency
FEAD = format for electronic analytical data
FTB = full trip blank
GC = gas chromatography
GC/MS = gas chromatography/mass spectrometry
IC = ion chromatography
ICP-AES = inductively coupled plasma atomic emission spectrometry
LCS = laboratory control sample
Data Flags

MB = method blank
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PS = post digestion spike
QC = quality controlRDL = required detection limit
RPD = relative percent difference
SUR = surrogate

Table A-5. Laboratory Quality Control and Acceptance Criteria

Analysis	Quality Control	Acceptance Criteria	Corrective Action
B (organics) = analyte was detected in both the associated QC blank and the sample) C (inorganics/wetchem) = The analyte was detected in both the sample and the associated QC blank and the blank value exceeds 5% of the measured concentration present in the associated sample.		N = all except GC/MS – matrix spike outlier T = volatile organic analysis and semivolatile organic analysis GC/MS – matrix spike outlier Q = associated QC sample is out of limits	

A3.3.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure that reliable data are obtained. Field QC samples include field duplicates, field split (SPLIT) samples, and two types of field blanks (full trip blanks [FTBs] and equipment blanks [EBs]). Field blanks are typically prepared using high-purity reagent water. QC sample definitions and their required frequency for collection are described in this section:

Field Duplicates: independent samples collected as close as possible to the same time and same location as the scheduled sample, and are intended to be identical. Field duplicates are placed in separate sample containers and analyzed independently. Field duplicates are used to determine precision for both sampling and laboratory measurements.

Field Splits: two samples collected as close as possible to the same time and same location and are intended to be identical. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.

Full Trip Blanks: bottles prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. It is filled with high-purity reagent water, and the bottles are sealed and transported (unopened) to the field in the same storage containers used for samples collected that day. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

Equipment Blanks: reagent water passed through or poured over the decontaminated sampling equipment identical to the sample set collected and placed in sample containers, as identified on the SAF. EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. EB samples will be analyzed for the same constituents as the samples from the associated sampling event. EBs are used to evaluate the effectiveness of the decontamination process. EBs are not required for disposable sampling equipment.

A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by the laboratories utilized by the project. Laboratory QA includes a comprehensive QC program that includes the use of matrix spikes (MSs), matrix duplicates, matrix spike duplicates (MSDs), laboratory control samples (LCSs), surrogates (SURs), post-digestion spikes (PSs), and method blanks (MBs). These QC analyses are required by EPA methods (e.g., those in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended), and will be run at the frequency specified in the respective references unless superseded by agreement. QC checks outside of control limits are documented in analytical laboratory reports during DQAs, if performed. Laboratory QC and their typical frequencies are listed in Table A-4. Acceptance criteria are shown in Table A-5. The following text describes the various laboratory QC samples:

Laboratory Duplicate: an intralaboratory replicate sample that is used to evaluate the precision of a method in a given sample matrix.

Matrix Spike: an aliquot of a sample spiked with a known concentration of target analyte(s). MS is used to assess the bias of a method in a given sample matrix. Spiking occurs prior to sample preparation and analysis.

Matrix Spike Duplicate: a replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.

Post-Digestion Spike: the same as MS; however, the spiking occurs after sample preparation and before analysis.

Laboratory Control Sample: a control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.

Method Blank: an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparations and analytical procedure and is used to quantify contamination resulting from the analytical process.

Surrogate: a compound added to all samples in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, yet are not normally encountered. SURs are expected to respond to the preparation and measurement systems in a manner similar to the analytes of interest. Because SURs are added to all standards, samples, and QC samples, they are used to evaluate overall method performance in a given matrix. SURs are used only in organic analyses.

Laboratories are required to analyze samples within the holding time specified in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilizing, decomposing, or other chemical changes. Data from samples analyzed outside the holding times are flagged in the HEIS database with an "H."

Table A-6. Preservation, Container, and Holding Time Guidelines for Laboratory Analyses

Constituent/ Parameter	Minimum Volume	Container Type[a]	Preservation[b]	Holding Time
Alkalinity (includes bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity)	500 mL	Narrow mouth poly or glass	Store ≤ 6°C	14 days
Total Organic Carbon	250 mL	Narrow mouth amber glass with Teflon®-lined lid	Store ≤ 6°C, Adjust pH to < 2 with H_2SO_4 or HCl	28 days

Table A-6. Preservation, Container, and Holding Time Guidelines for Laboratory Analyses

Constituent/ Parameter	Minimum Volume	Container Type[a]	Preservation[b]	Holding Time
Total Organic Halogen	1 L	Narrow mouth glass with Teflon®-lined lid	Store ≤ 6°C, Adjust pH to < 2 with H_2SO_4	28 days
Anions by IC (Chloride, Fluoride, Nitrate, Nitrite, and Sulfate)	60 mL	Narrow mouth poly or glass	Store ≤ 6°C	48 hours
ICP Metals (Calcium Iron, Magnesium, Manganese, Potassium and Sodium)	250 mL	Narrow mouth poly or glass	Adjust pH to < 2 with nitric acid	6 months
Phenols by GC or GC/MS	4 × 1L	Narrow mouth amber glass with Teflon®-lined lid	Store ≤ 6°C	7 days before extraction 40 days after extraction

Note:

Teflon is a registered trademark of E.I. du Pont de Nemours and Company, Wilmington, Delaware.

The information in this table does not represent EPA requirements but is intended solely as guidance.

This table only applies to laboratory analyses. Specific conductance, pH, temperature, and turbidity are not listed as they are measured in the field.

a. Under the Container heading, the term poly stands for EPA clean polyethylene bottles.

b. For preservation identified as stored at ≤ 6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

GC = gas chromatography

GC/MS = gas chromatography/mass spectrometry

H_2SO_4 = sulfuric acid

HCl = hydrochloric acid

IC = ion chromatography

ICP = inductively coupled plasma

A3.4 Measurement Equipment

Each user of the measuring equipment is responsible to ensure that equipment is functioning as expected, properly handled, and properly calibrated at required frequencies in accordance with methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with manufacturer specifications and other approved methods.

A3.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or should have been evaluated as acceptable and valid in accordance with instrument-specific methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory will be subject to preventive maintenance measures to ensure minimization of downtime. Laboratories must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent applicable Hanford Site requirements.

A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B. Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with test methods in SW-846 and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

A3.8 Nondirect Measurements

Data obtained from sources, such as computer databases, programs, literature files, and historical databases, will be technically reviewed to the same extent as the data generated as part of any sampling and analysis QA/QC effort. All data used in evaluations will be identified by source.

A3.9 Data Management

The SMR group, in coordination with the S&GRP RCRA groundwater manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management methods.

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR group on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and establish their resolution with the S&GRP RCRA groundwater manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and records management.

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A4 Assessment and Oversight

Assessment and oversight activities address the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

A4.1 Assessments and Response Actions

Random surveillances and assessments verify compliance with the requirements outlined in this plan, project field instructions, the QAPjP, methods, and regulatory requirements. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies resolutions in accordance with the QA program, corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the S&GRP RCRA groundwater manager.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with laboratory QA plans. The contractor oversees offsite analytical laboratories and verifies that laboratories are qualified for performing Hanford Site analytical work.

A4.2 Reports to Management

Management will be made aware of deficiencies identified by self assessments, corrective actions from ECOs, and findings from QA assessments and surveillances. Issues reported by the laboratories are communicated to the SMR group, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and establish resolution with the S&GRP RCRA groundwater manager.

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A5 Data Review and Usability

This section addresses the QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

A5.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times have been met, and reviewing QC data to determine whether analyses have met the data quality requirements specified in this plan.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results also will be reviewed to ensure that they are usable.

The project scientist, assigned by the S&GRP RCRA groundwater manager, will perform a data review to help determine if observed changes reflect improved/degraded groundwater quality or potential data errors and may result in submittal of a request for data review (RDR) on questionable data. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the RDR process are used to flag the data appropriately in the HEIS database and/or to add comments.

A5.2 Data Validation

Data validation activities may be performed at the discretion of the S&GRP RCRA groundwater manager and under the direction of the SMR group. If performed, data validation activities will be based on EPA functional guidelines.

A5.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the DQA is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project data quality needs. For routine groundwater monitoring undertaken through this integrated SAP, the DQA is captured in QC associated with the annual Hanford Site groundwater report, which evaluates field and laboratory QC and the usability of data. Further DQAs will be performed at the discretion of the S&GRP RCRA groundwater manager and documented in a report overseen by the SMR group.

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A6 References

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Appendix B

Sampling Protocol

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Contents

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Terms

CFR	Code of Federal regulations
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
FWS	Field Work Supervisor
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
IATA	International Air Transport Association
NTU	nephelometric turbidity unit
RCRA	*Resource Conservation and Recovery Act of 1976*
S&GRP	Soil and Groundwater Remediation Project
SMR	Sampling Management and Reporting

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B1 Introduction

Resource Conservation and Recovery Act of 1976 (RCRA) groundwater monitoring at the Hanford Site has been conducted since the mid 1980's. Hanford Site groundwater sampling methods contain extensive requirements for sampling precautions to be taken, equipment and its use, cleaning and decontamination, records and documentation, and sample collection, management, and control activities. Appendices A and B, together, provide the sampling and analysis essentials (sample collection, sample preservation, chain of custody control, analytical procedures, and field and laboratory quality assurance/quality control) necessary for the groundwater monitoring plan.

This appendix provides more specific elements of the sampling protocols and techniques used for the RCRA groundwater monitoring plan. Chapter 3 of the groundwater monitoring plan identifies the monitoring wells that will be sampled, the constituents to be analyzed for, and the sampling frequency for the groundwater monitoring at the 216-A-37-1 Crib.

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B2 Sampling Methods

Sampling methods may include, but are not limited to, the following:

- Field screening measurements
- Groundwater sampling
- Water level measurements

Groundwater samples will be collected according to the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- pH – two consecutive measurements agree within 0.2 pH units
- Temperature – two consecutive measurements agree within 0.2°C
- Conductivity – two consecutive measurements agree within 10 percent of each other
- Turbidity – less than 5 nephelometric turbidity units (NTUs) prior to sampling (or project scientist's recommendation)

Absent any special requirements from project scientists, wells are purged utilizing the three borehole volume method. Stable field readings are also required as specified above. The default pumping rate is 7.6 to 45.4 L/min (2 to 12 gal/min) depending on the pump, although this is not practical at every well. On occasions when the purge volume is extraordinarily large, wells are purged a minimum of an hour and then sampled once stable field readings are obtained.

Field measurements (except for turbidity) are obtained through the use of a flow through cell. Groundwater is pumped directly from the well and to the flow through cell. At the beginning of the sample event, field crews attach a clean stainless steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other is used to supply water to the flow through cell. Probes are inserted into the flow through cell for measurement of pH, temperature, conductivity. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is then discharged to the purgewater truck.

Once field measurements have stabilized, the hose supplying water to the flow through cell is disconnected and a clean stainless steel drop leg is attached for sampling. The flow rate is reduced during sampling to minimize loss of volatiles, if any, and prevent over filling of bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles, if any. Filtered samples are collected after the unfiltered samples. For some constituents, like metals, both filtered and unfiltered samples are analyzed. If additional samples require filtration (e.g., at turbidity greater than 5 NTUs), an inline disposable 0.45 μm filter is used.

Typically, three types (i.e., Grundfos, Hydrostar, and submersible electrical pumps) of environmental grade sampling pumps are used for groundwater sampling at Hanford Site monitoring wells. Individual pumps are selected based on the unique characteristics of the well and the sampling requirements. A small number of wells will not support a pumped sample because of yield or the physical characteristics of the well. In these cases, a grab sample may be obtained.

For certain types of samples, preservatives are required. While the preservative may be added to the collection bottles before their use in the field, it is allowable to add the preservative at the sampling vehicle immediately after collection. Samples may require filtering in the field, as noted on the chain-of-custody form.

To ensure sample and data usability, the sampling associated with this plan will be performed according to DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), pertaining to sample collection, collection equipment, and sample handling.

Suggested sample container, preservation, and holding time requirements are specified in Appendix A (Table A-6) for groundwater samples. These requirements are in accordance with the analytical method specified in Appendix A (Tables A-3a and A-3b). The final container type and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a "sample" as a filled sample bottle for starting the clock for holding time restrictions.

Holding time is the maximum allowable time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the constituent and are listed in analytical method compilations such as APHA et al., 2012, *Standard Methods for the Examination of Water and Wastewater*, and SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition; Final Update IV-B*. Recommended holding times are also provided in HASQARD (DOE/RL-96-68).

B2.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

B2.2 Water Levels

Each time a sample is obtained, measurement of the ground water surface elevation at each monitoring well is required by Title 40 *Code of Federal Regulations* (CFR) 265.92(e) "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." A measurement of depth to water is recorded in each well prior to sampling, using calibrated depth measurement tapes. Two consecutive measurements are taken that agree within 6 mm (0.02 ft); these are recorded along with the date, time, measuring tape number, and other pertinent information. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of casing) to obtain the water level elevation. Tops of casings are known elevation reference points because they have been surveyed to local reference data.

B3 Documentation of Field Activities

Logbooks or data forms are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling Field Work Supervisor (FWS), cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms may be used to collect field information; however, the information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks is as follows:

- The day and date, time the task started, weather conditions, and the names, titles, and organizations of personnel performing the task.
- The purpose of the visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Details of any field tests that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and indicate the preparation, if any, of splits, duplicates, matrix spikes, or blanks. Reference the methods followed in sample collection or preparation. List location of sample collected, sample type, all label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and the analytical request form number pertinent to each sample or sample set. Note the time and the name of the individual to whom custody of samples was transferred.
- The time, equipment type, and serial or identification number, and the methods followed for decontaminations and equipment maintenance performed. Reference the page number(s) of any logbook (if any) where detailed information is recorded.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

B3.1 Corrective Actions and Deviations for Sampling Activities

The Soil and Groundwater Remediation Project (S&GRP) RCRA groundwater manager, FWS, appropriate field crew supervisors, and Sampling Management and Reporting (SMR) personnel must document deviations from protocols, problems pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions.

As appropriate, such deviations or problems will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The S&GRP RCRA groundwater manager, FWS, field crew supervisors, or SMR personnel will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Appendix A (Table A-2).

B4 Calibration of Field Equipment

Field instrumentation, calibration, and quality assurance checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified quality control criteria.
- Daily calibration checks will be performed and documented for each instrument used. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Standards used for calibration will be traceable to a nationally recognized standard agency source or measurement system.

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B5 Sample Handling

Sample handling and transfer will be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and analytical data tracking database is used to track the samples from the point of collection through the laboratory analysis process.

B5.1 Containers

Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the laboratory lot number of the bottles used in sample collection. When commercially pre-cleaned containers are used in the field, the name of the manufacturer, lot identification, and certification shall be retained for documentation.

Containers shall be capped and stored in an environment which minimizes the possibility of contamination of the sample containers. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/ requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified in Appendix A (Table A-6).

B5.2 Container Labeling

Each sample is identified by affixing a standardized label or tag on the container. This label or tag shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

B5.3 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to the SMR group within 48 hours of shipping.

The following minimum information is required on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number

- Date and time of collection
- Matrix
- Preservatives
- Chain of possession information (i.e., signatures and printed names of all individuals involved in the transfer of sample custody and storage locations, and dates of receipt and relinquishment)
- Requested analyses (or reference thereto)
- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group so that special direction for analysis may be provided to the laboratory if deemed necessary.

B5.4 Sample Transportation

All packaging and transportation instructions shall be in compliance with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "General Information, Regulations, and Definitions," through 49 CFR 177, "Carriage by Public Highway." Carrier specific requirements defined in the International Air Transport Association (IATA) *Dangerous Goods Regulations* (IATA, current edition) shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material and appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

B6 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2004-18, "*Waste Control Plan for the 200-PO-1 Groundwater Operable Unit*". For waste designation purposes, the wells listed in Table 3-1 will be surveyed in the Hanford Environmental Information System and the maximum concentration for each analyte within the most recent 5 years evaluated for use in creating a waste profile, if required. Offsite analytical laboratories are responsible for disposal of unused sample quantities. Pursuant to 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," approval from the DOE Richland Operations Office is required before returning unused samples or waste from offsite laboratories.

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B7 Health and Safety

The safety and health program is designed to ensure the safety and health of workers including those involved in dangerous waste site activities. The program was developed to comply with the requirements of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," and 10 CFR 835, "Occupational Radiation Protection" (Chapter III, "Energy"). The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training, control of industrial safety and radiological hazards, personal protective equipment, site control, and general emergency response to spills, fire, accidents, injury, site visitors, and incident reporting are governed by the health and safety program.

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B8 References

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49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

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49 CFR 175, "Carriage by Aircraft."

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http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL2-04.pdf,
http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf,
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Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

Appendix C

Well Construction

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Contents

Figures

Tables

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C1 Introduction

This appendix provides the following information for the 216-A-37-1 groundwater monitoring wells:

- Well name
- Hydrogeologic unit to be monitored – the portion of the aquifer that is located at the well screen or perforated casing (Table C-1)
- The following sampling interval information, as shown in Table C-2:
  - Distance below ground surface (bgs) at the top of the screen or perforated interval
  - Distance bgs at the bottom of the screen or perforated interval
  - Open interval length (i.e., difference between top and bottom of the screen or perforated interval)

Figures C-1 through C-5 provide well construction and completion summaries for the wells that monitor the 216-A-37-1 Crib.

Table C-1. Hydrogeologic Monitoring Unit Classification Scheme

Unit	Description
TU	**Top of Unconfined** – screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table.

Table C-2. Sampling Interval Information for Wells within the 216-A-37-1 Network

Well or Aquifer Tube Name	Hydrogeologic Unit Monitored	Screen Top (m [ft] bgs)	Screen Bottom (m [ft] bgs)	Open Interval Length (m [ft])
299-E25-17	TU	83.2 (273)	89.9 (295)	6.7 (22)
299-E25-19	TU	82.3 (270)	89.9 (295)	7.6(25)
299-E25-20	TU	82.0 (269)	89.6 (294)	7.6 (25)
299-E25-47	TU	80.2 (263)	86.3 (283.2)	6.2 (20.2)
299-E25-48	TU	83.6 (274.3)	89.8 (294.6)	6.2 (20.3)

bgs = below ground surface
TU = Top of Unconfined (as described in Table C-1)

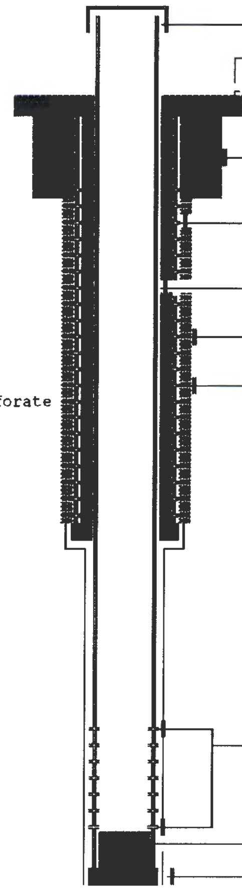
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-E25-17 / TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Bentonite	Hanford Coordinates: N/S N 40,086 E/W W 46,570
Driller's Name: H. Baker	WA State Lic Nr: Not documented	State Coordinates: N 445,268 E 2,248,652
Drilling Company: Not documented	Company Location: Pasco, WA	Start Card #: Not documented T___ R___ S___
Date Started: 24May76	Date Complete: 21Jul76	Elevation Ground surface: 688.1-ft Estimated

Depth to water: ~275 ft Jul76
(Ground surface) 271.4-ft Mar92

GENERALIZED STRATIGRAPHY Driller's Log

0-5: 90%f-cSAND, 10%fGRAVEL
5-20: 80%f-cSAND, 20%fGRAVEL
20-25: 70%f-cSAND, 30%fGRAVEL
25-30: vf-cSAND
30-50: 90%f-cSAND, 10%fGRAVEL
50-55: f-cSAND
55-65: 90%f-cSAND, 10%fGRAVEL
65-75: f-cSAND
75-85: 90%f-cSAND, 10%fGRAVEL
85-90: 80%f-cSAND, 20%fGRAVEL
90-95: 60%f-cSAND, 40%fGRAVEL
95-100: 80%f-cSAND, 20%fGRAVEL
100-120: 80%f-cSAND, 20%mGRAVEL
120-132: 70%m-cSAND, 30%fGRAVEL
(2-in SILT @ 125-ft)
132-133: SILT & vfSAND
133-150: 80%f-cSAND, 20%fGRAVEL
(Stopped drilling to perforate and grout)
150-160: 60%f-cSAND, 40%fGRAVEL
160-175: 60%m-cSAND, 40%f-mGRAVEL
175-180: 80%f-cSAND, 20%fGRAVEL
180-185: f-cSAND
185-190: 80%f-cSAND, 20%fGRAVEL
190-210: 70%m-cSAND, 30%fGRAVEL
210-220: 80%f-cSAND, 20%fGRAVEL
220-225: 60%f-cSAND, 20%GRAVEL, 20%COBBLES
225-245: Not documented
245-300: 60%m-cSAND, 40%fGRAVEL



Elevation of reference point: [690.00-ft]
(top of casing)
Height of reference point above [1.9-ft]
ground surface

Depth of surface seal [20.0-ft]
Type of surface seal:
Cement grout between 8 and 16-in casings 0-20-ft, as 16-in assumed pulled back.
2-ft pad, depth indeterminate

8-in ID carbon steel casing, 0-150-ft

6-in ID carbon steel casing, +1.9-300-ft

Hole diameter, 9-in nominal 20-150-ft

Annular seal,
Bentonite mud/cement
Perforated 20-127 ft, 4 cuts/rd/ft
Grouted w/bentonite drilling mud,
Filled casing with cement and drilled out. Cement grouted between 6 & 8-in casing.

6-in casing perforations, 273-295-ft, 4 cuts/rd/ft

Cement plug 295-300-ft

Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-17.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-1. Well 299-E25-17 Construction and Completion Summary

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-17

WELL DESIGNATION	:	299-E25-17
RCRA FACILITY	:	Not applicable
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 40,086 W 46,570
LAMBERT COORDINATES	:	N 445,268 E 2,248,652
DATE DRILLED	:	Jul76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	~275-ft, Jul76; 271.4-ft, 26Mar92
CASING DIAMETER	:	8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +1.9-300-ft
ELEV TOP CASING	:	690.00-ft
ELEV GROUND SURFACE	:	688.1-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 20-127-ft; 6-in casing, 273-295-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 03Mar92, 6-in carbon steel casing. Capped and locked ~2-ft pad, no posts, no permanent identification. Not in radiation zone.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured 07Jan86-26Mar92,
CURRENT USER	:	PNL sitewide sampling 93
PUMP TYPE	:	None documented
MAINTENANCE	:	

Figure C-1. Well 299-E25-17 Construction and Completion Summary (continued)

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Baker
Drilling Company: Not documented
Date Started: 22Jul76

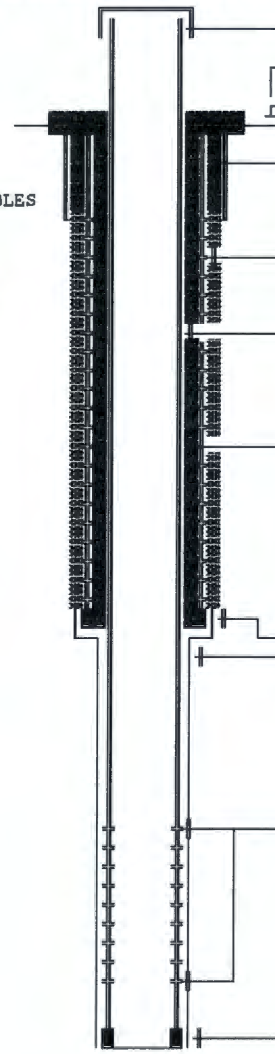
Sample Method: Hard tool (nom)
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 03Sep76

WELL NUMBER: 299-E25-19
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,935 E/W W 46,060
State Coordinates: N 445,119 E 2,249,163
Start Card #: Not documented T R S
Elevation Ground surface: Not documented

Depth to water: 272 ft Sep76
(Ground surface) -274-ft 17Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0-40: GRAVEL and SAND
40-65: SAND with GRAVEL
65-95: GRAVEL and SAND
95-125: SAND and GRAVEL, some COBBLES
125-130: SAND
130-145: SAND with GRAVEL
145-215: SAND and GRAVEL
215-220: SAND
220-255: SAND, GRAVEL and COBBLES
255-260: SAND
260-300: GRAVEL and SAND



Elevation of reference point: (top of casing) [677.20-ft]
Height of reference point above ground surface [ND]
Depth of surface seal [20.0-ft]
Type of surface seal:
Cement grout between 8 and 10-in casing 0-20 ft, 10-in casing left in hole
2-ft pad, depth indeterminate
8-in ID carbon steel casing, 0-150-ft
6-in ID carbon steel casing, +ND-300-ft
Annular seal,
Bentonite grout between 6 & 8-in casing
Perforated 20-150-ft, 4 cuts/rd/ft
Grouted with bentonite. Bentonite bailed and grouted w/cement. Bailed cement and set 6-in casing. Grouted between 6 & 8-in; 8 & 10-in casings. Used 300-gals.
Hole diameter,
20-150-ft, 9-in nominal
150-300-ft, 7-in nominal
6-in casing perforations, 270-295-ft, 4 holes/ft
Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-19.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-2. Well 299-E25-19 Construction and Completion Summary

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-19

WELL DESIGNATION	:	299-E25-19
RCRA FACILITY	:	A-29 Ditch
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 39,935 W 46,060
LAMBERT COORDINATES	:	N 445,119 E 2,249,4163
DATE DRILLED	:	Sep76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	272-ft, Sep76; ~274-ft 17Jun93
CASING DIAMETER	:	10-in carbon steel, 0-10-ft; 8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +ND-300-ft
ELEV TOP CASING	:	677.20-ft, [15May86]
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	8-in casing, 20-150; 6-in casing, 270-295-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 22Aug89, 6-in carbon steel casing. Capped and locked 2-ft pad, no posts, no permanent identification.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A29 Ditch Quarterly water level measurement, 09Dec86-17Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

Figure C-2. Well 299-E25-19 Construction and Completion Summary (continued)

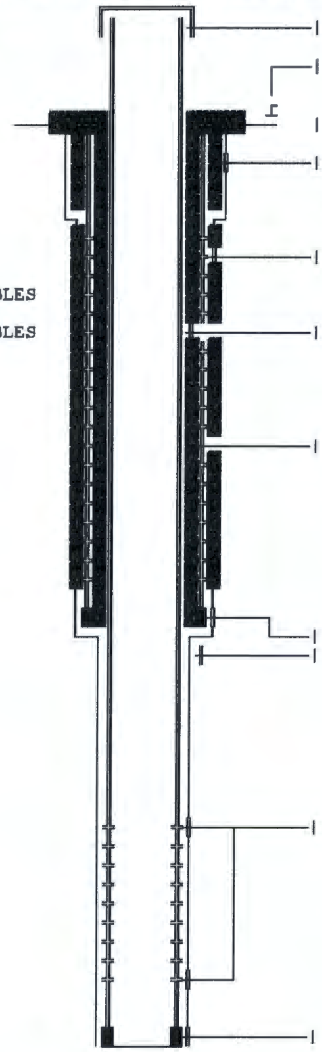
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-E25-20 — TEMPORARY WELL NO: 4
Drilling Fluid Used: Water	Additives Used: Bentonite	Hanford Coordinates: N/S N 39,925 — E/W W 45,875
Driller's Name: Egan	WA State Lic Nr: Not documented	State Coordinates: N 445,109 — E 2,249,348
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented — T___ R___ S___
Date Started: 20May76	Date Complete: 06Aug76	Elevation Ground surface: Not documented

Depth to water: 271-ft Aug76
(Ground surface) -273-ft 17Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0-160: SAND
160-175: Pebbly SAND
175-190: SAND
190-200: Pebbly SAND
200-210: SAND and PEBBLES
210-215: SAND
215-220: Pebbly SAND
220-225: SAND
225-245: SAND & PEBBLES, some COBBLES
245-260: SAND and COBBLES
260-270: SAND & PEBBLES, some COBBLES
270-280: SAND & PEBBLES
280-300: SAND, PEBBLES & COBBLES



Elevation of reference point: (top of casing) [676.30-ft]

Height of reference point above ground surface [ND]

Depth of surface seal [20.0-ft]

Type of surface seal:
Cement grout between 8 and 10-in casing 0-20-ft as 10-in pulled back.
2-ft pad, depth indeterminate

8-in ID carbon steel casing, 0-150-ft

6-in ID carbon steel casing, +ND-300-ft

Annular seal,
Cement grout between 6 and 8-in casing.
Perforated 21-149-ft, 4 cuts/rd/ft.
Used 270-gals cement
at 5.5-gals water/bag cement.

Hole diameter,
20-150-ft, 9-in nominal
150-300-ft, 7-in nominal

6-in casing perforations,
269-294-ft, 4 cuts/rd

Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-20.ASB
Date : 07Sep93
Reference : HANFORD WELLS

Figure C-3. Well 299-E25-20 Construction and Completion Summary

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-20

WELL DESIGNATION	:	299-E25-20
RCRA FACILITY	:	A-29 Ditch
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 39,925 W 45,875
LAMBERT COORDINATES	:	N 445,109 E 2,249,348
DATE DRILLED	:	Aug76
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	271-ft, Aug76; ~273-ft, 17Jun93
CASING DIAMETER	:	8-in, carbon steel, 0-150-ft; 6-in, carbon steel, +ND-300-ft
ELEV TOP CASING	:	676.47-ft, [27Mar92-NGVD'29]
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	21-149 and 269-294-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 22Aug89, 6-in carbon steel casing. Capped and locked 2-ft pad, no posts, no permanent identification.
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A29 Ditch Quarterly water level measurement, 01Jan87-17Jun93;
CURRENT USER	:	WHC ES&M w/1 monitoring, sampling and RCRA sampling; PNL sitewide sampling 93
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

Figure C-3. Well 299-E25-20 Construction and Completion Summary (continued)

A4794 / 299-E25-47

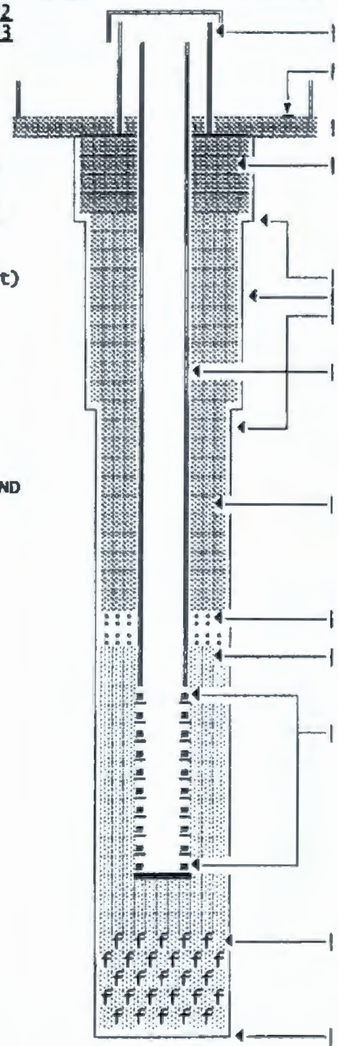
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Downhole hammer Backhoe/Air rotary	Sample Method: Air returns Continous	WELL NUMBER: 299-E25-47 — TEMPORARY WELL NO:
Drilling Fluid Used: None	Additives Used: None documented	Hanford Coordinates: N/S N 40,835.3 E/W W 46,306.1
Driller's Name: D. Mingo	WA State Lic Nr: Not documented	State NAD83 N 135,931.0m 575,778.6m
Drilling Company: Jensen Drilling Co	Company Location: Not documented	Coordinates: N 446,018 E 2,248,914
Date Started: 14Jul92	Date Complete: 06Aug92	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 670.41-ft (Brass cap)

Depth to water: 266.7-ft 06Aug92
(Ground surface) 268.0-ft 22Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0↔24: SAND
24↔30: Sl gravelly (pebbly) SAND
30↔100: SAND
(1-in SILT lens @ 90-ft)
100↔115: Sl silty sandy (pebble) GRAVEL
115↔130: SAND
130↔162: SILT (SAND lens @ 144-ft)
162↔175: SAND
175↔180: Gravelly SAND
180↔195: SAND
195↔225: Gravelly (pebble) SAND
225↔228: SILT
228↔262: SAND
(HANFORD Fine/RINGOLD contact @ 262-ft)
262↔266: SILT
266↔280: SAND
280↔295: Sl gravelly (pebbly) SAND
295↔300: Gravelly (pebbly) SAND
300↔301.4: SAND



Elevation of reference point: [673.77-ft]
(top of casing)

Height of reference point above ground surface [3.36-ft]

Depth of surface seal [2.0↔9.8-ft]

Type of surface seal:
Cement grout, 2.0↔9.8-ft
4x4-ft x 4-in concrete pad extends 2.0-ft into annulus

Hole diameter,
2.0↔9.9-ft, 13-in nominal
9.9↔162.3-ft, 11-in nominal
162.3↔301.4-ft, 9-in nominal

4-in ID T304 stainless steel casing,
+1.0↔263.0-ft

Bentonite crumbles,
9.8↔256.1-ft, 8↔20-mesh

3/8-in bentonite pellets,
256.1↔259.4-ft

Silica sand pack,
259.4↔288.9-ft, 20↔40-mesh
288.9↔291.7-ft, 10↔20-mesh

4-in T304 stainless steel screen,
263.0↔283.2-ft, #10-slot
w/cap

Fill,
291.7↔301.4-ft

Borehole drilled depth: [301.4-ft]

Drawing By: RKL/2E25-47.ASB
Date : 08Sep93
Reference : WHC-SD-EN-DP-054

Figure C-4. Well 299-E25-47 Construction and Completion Summary

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-47

WELL DESIGNATION :	299-E25-47
RCRA FACILITY :	Grout
CERCLA UNIT :	Not applicable
HANFORD COORDINATES :	N 40,835.4 W 46,306.1 [30Dec92-200E]
LAMBERT COORDINATES :	N 446,018 E 2,248,914 [HANCONV]; N 135,931.0m E 575,778.6m [NAD83-30Dec92]
DATE DRILLED :	Aug92
DEPTH DRILLED (GS) :	301.4-ft
MEASURED DEPTH (GS) :	283.6-ft, 03Nov92
DEPTH TO WATER (GS) :	266.7-ft, 06Aug92 268.0-ft, 22Jun93
CASING DIAMETER :	6-in, stainless steel, +3.4↔-0.5-ft; 4-in, stainless steel, +1.0↔263.0-ft
ELEV TOP CASING :	673.77-ft, [30Dec92-NGVD'29]
ELEV GROUND SURFACE :	670.41-ft, Brass cap [30Dec92-NGVD'29]
PERFORATED INTERVAL :	Not applicable
SCREENED INTERVAL :	263.0↔283.2-ft, 4-in stainless steel, #10-slot
COMMENTS :	FIELD INSPECTION, 03Nov92; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS :	Geologist
TV SCAN COMMENTS :	Not applicable
DATE EVALUATED :	Not applicable
EVAL RECOMMENDATION :	Not applicable
LISTED USE :	A-29 Ditch monthly water level measurement, 14Dec92↔22Jun93;
CURRENT USER :	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE :	Hydrostar, @ 281.0-ft (GS)
MAINTENANCE :	

Figure C-4. Well 299-E25-47 Construction and Completion Summary (continued)

WELL CONSTRUCTION AND COMPLETION SUMMARY A4795

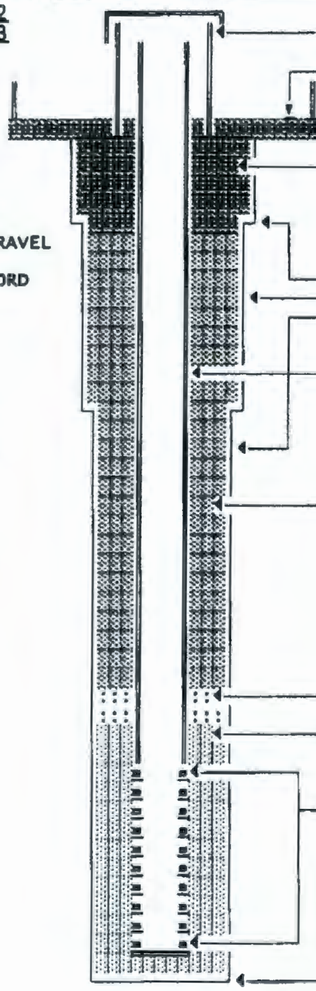
Drilling Method: Backhoe/Air rotary; Downhole hammer	Sample Method: Continous; Air returns
Drilling Fluid Used: None	Additives Used: None documented
Driller's Name: D. Mingo	WA State Lic Nr: Not documented
Drilling Company: Jensen Drilling Co	Company Location: Not documented
Date Started: 01Jul92	Date Complete: 01Oct92

WELL NUMBER: 299-E25-48	TEMPORARY WELL NO:
Hanford Coordinates: N/S N 40,456.8	E/W W 46,816.1
State NAD83 N 135,815.16m	575,623.43m
Coordinates: N 445,638	E 2,248,405
Start Card #: Not documented	T___ R___ S___
Elevation Ground surface: 679.68-ft (Brass cap)	

Depth to water: 276.3-ft 25Aug92
(Ground surface) 277.0-ft 22Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0↔20: SAND
20↔30: Gravelly (pebbly) SAND
30↔40: Sandy (pebble) GRAVEL
40↔50: Sl gravelly (pebbly) SAND
50↔60: Sandy (pebble) GRAVEL
60↔75: Sl silty sandy (pebble) GRAVEL
75↔85: (Pebble) GRAVEL
HANFORD Upper coarse/HANFORD Fine contact @85-ft
85↔90: (Pebbly) gravelly SAND
90↔110: Sl silty SAND
110↔202: SAND
202↔208: Silty SAND
208↔220: SAND
220↔225: (Pebbly) gravelly SAND
225↔230: Sandy (cobble) GRAVEL
230↔235: (Pebbly) gravelly SAND
235↔245: SAND
245↔248: Silty SAND
248↔266.5: SAND
HANFORD Fine/RINGOLD contact @ 266.5-ft
266.5↔280: Sandy SILT
280↔285: Sl gravelly SAND
285↔295: Sl sandy GRAVEL
295↔297.5: Sandy GRAVEL



Elevation of reference point: (top of casing) [682.31-ft]
Height of reference point above ground surface [2.63-ft]
Depth of surface seal [2.0↔10.3-ft]
Type of surface seal:
Cement grout, 2.0↔10.3-ft
4x4-ft x 4-in concrete pad extends 2.0-ft into annulus

Hole diameter,
2.0↔9.5-ft, 13-in nominal
9.5↔168.8-ft, 11-in nominal
168.8↔297.5-ft, 9-in nominal

4-in ID stainless steel casing, +1.4↔274.3-ft

Bentonite crumbles, 10.3↔262.6-ft, 8↔20-mesh

3/8-in bentonite pellets 262.6↔268.4-ft

Silica sand pack, 268.4↔297.5-ft, 20↔40-mesh

4-in T304 stainless steel screen, 274.3↔294.6-ft, #10-slot w/cap

Borehole drilled depth: [297.5-ft]

Drawing By: RKL/2E25-48.ASB
Date : 08Sep93
Reference : WHC-SD-EN-DP-054

Figure C-5. Well 299-E25-48 Construction and Completion Summary

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E25-48

WELL DESIGNATION	:	299-E25-48
RCRA FACILITY	:	Grout
CERCLA UNIT	:	Not applicable
HANFORD COORDINATES	:	N 40,456.8 W 46,816.1 [30Dec92-200E]
LAMBERT COORDINATES	:	N 445,638 E 2,248,405 [HANCONV]; N 135,815.16m E 575,623.43m [NAD83-30Dec92]
DATE DRILLED	:	Oct92
DEPTH DRILLED (GS)	:	297.5-ft
MEASURED DEPTH (GS)	:	286.1-ft, 03Nov92
DEPTH TO WATER (GS)	:	276.3-ft, 25Aug92 277.0-ft, 22Jun93
CASING DIAMETER	:	6-in, stainless steel, +2.6↔-0.5-ft; 4-in, stainless steel, +1.4↔274.3-ft
ELEV TOP CASING	:	682.31-ft, [30Dec92-NGVD'29]
ELEV GROUND SURFACE	:	679.68-ft, Brass cap [30Dec92-NGVD'29]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	274.3↔294.6-ft, 4-in stainless steel, #10-slot
COMMENTS	:	FIELD INSPECTION, 03Nov92; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	A-29 Ditch monthly water level measurement, 14Dec92↔22Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 257.4-ft (GS)
MAINTENANCE	:	

Figure C-5. Well 299-E25-48 Construction and Completion Summary (continued)

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